This issue of the Journal of Electricity, published May 15th, contains the report of the Water Power Development Committee of the N. E. L. A., and is therefore held for release to the public until May 19th.

JOURNAL OF ELECTRICITY

VOL. 44 NO. 10 SAN FRANCISCO, MAY 15, 1920 PER COPY, 50 CENTS

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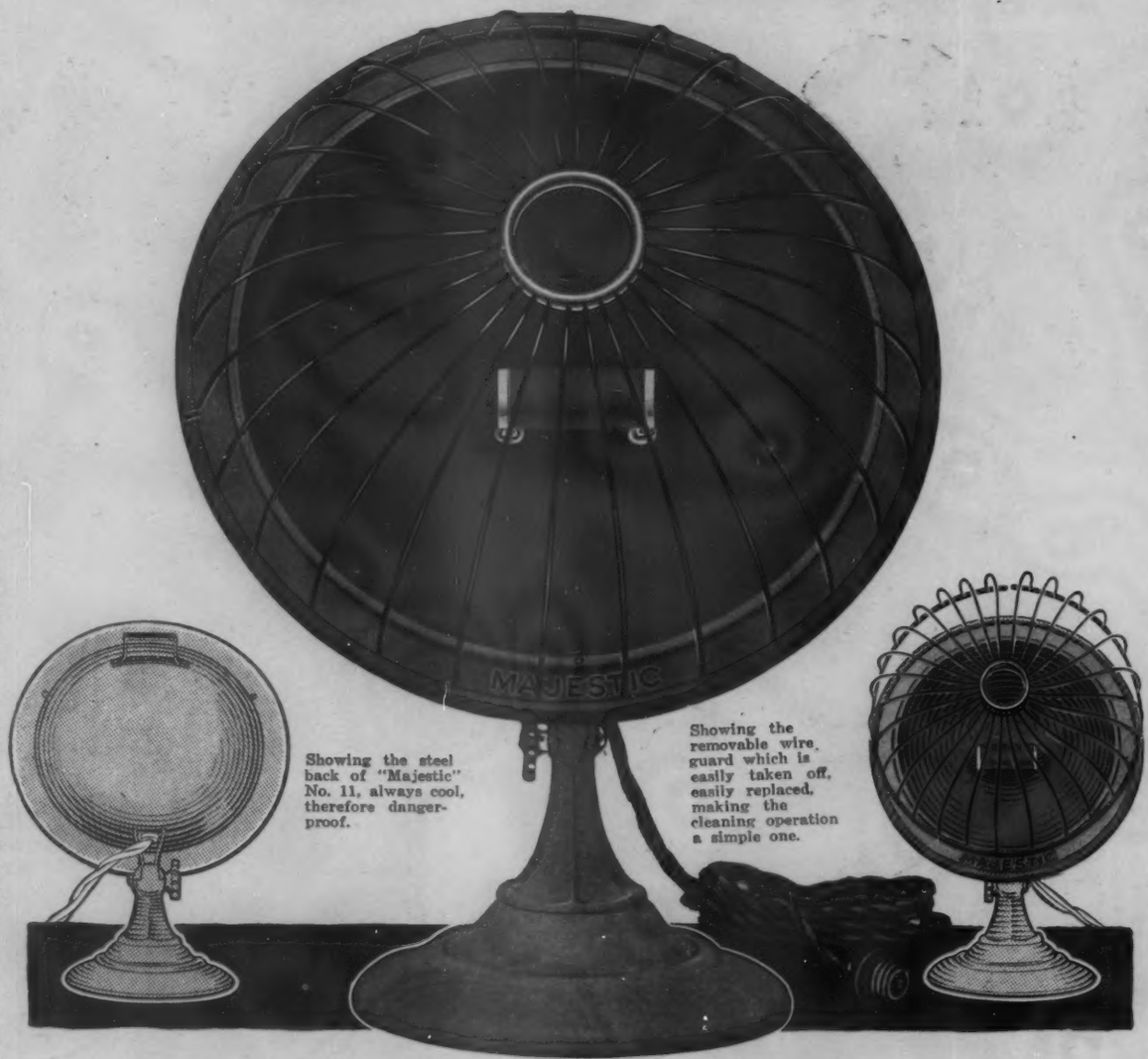

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JOURNAL OF ELECTRICITY

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ROBERT SIBLEY, Editor

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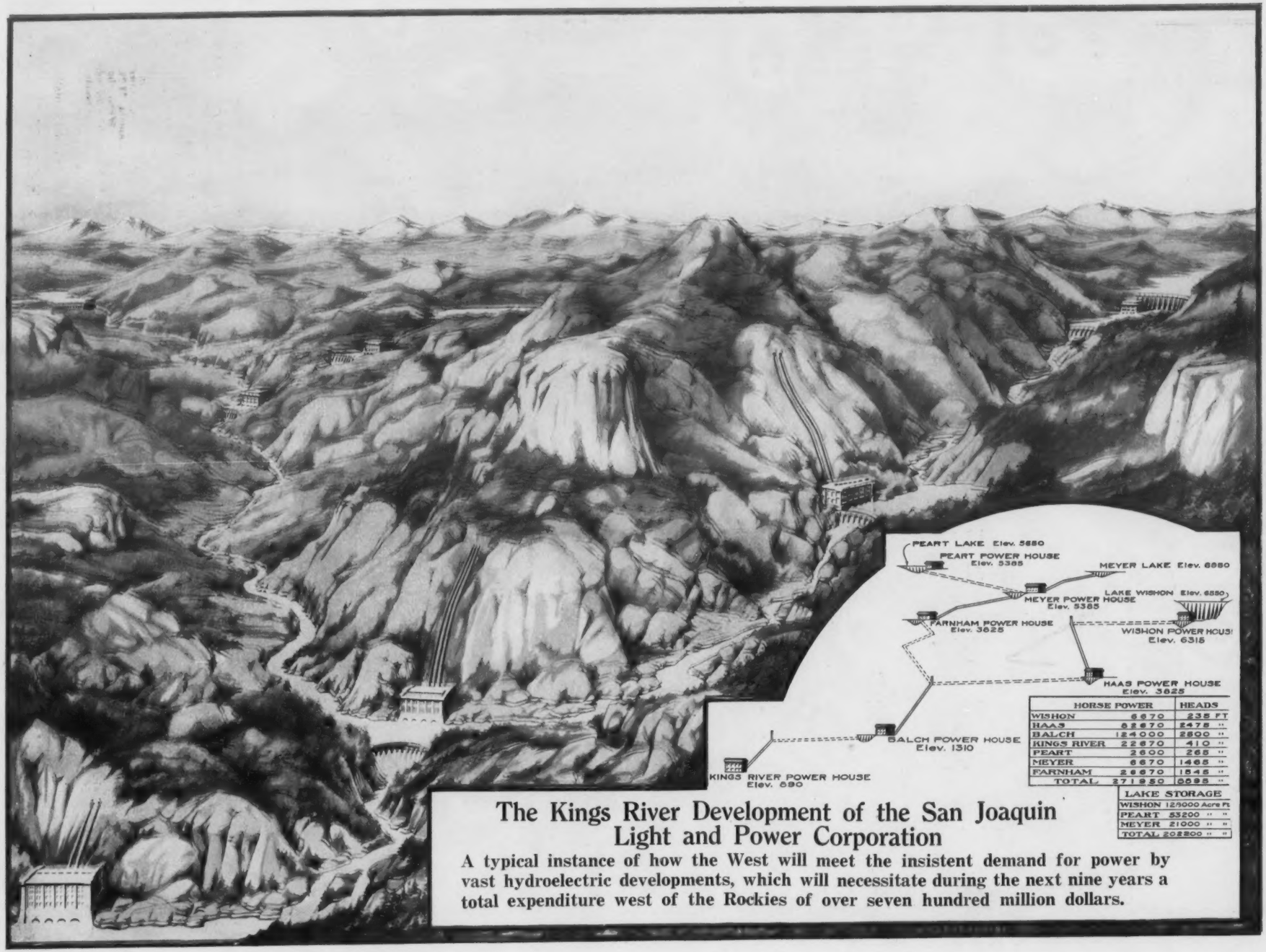

HORSE POWER		HEADS
WISHON	6670	235 FT
HAAS	82870	2478 "
BALCH	124000	2800 "
KINGS RIVER	22870	410 "
PEART	2600	265 "
MEYER	6670	1465 "
FARNHAM	26670	1545 "
TOTAL	271850	6095 "

LAKE STORAGE	
WISHON	125000 Acre Ft
PEART	53200 " "
MEYER	21000 " "
TOTAL	202200 " "

The Kings River Development of the San Joaquin Light and Power Corporation

A typical instance of how the West will meet the insistent demand for power by vast hydroelectric developments, which will necessitate during the next nine years a total expenditure west of the Rockies of over seven hundred million dollars.

MAY 25 1920
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JOURNAL OF ELECTRICITY

DEVOTED TO THE UPBUILDING OF THE ELECTRICAL INDUSTRY IN THE WEST AND IN THE COUNTRIES BORDERING THE GREAT PACIFIC

Volume 44 SAN FRANCISCO, MAY 15, 1920 Number 10

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What the N. E. L. A. Convention in the West Means to the Nation

IT is difficult fully to appraise the far-reaching effects of the National Electric Light Association Convention that is this year held in Pasadena, California. Many eventful years have in times past registered achievements of this organization that have meant much to the nation at large, and yet of all these years this year in particular is of unusual significance to men of the industry, and to the public at large. The shortage of power and the possibility of draining too heavily our natural resources in coal, fuel oil and natural gas, bring to light more forcefully than ever the necessity for new and vast creation in power development. From Pasadena, the West is enabled to make heard a voice that among the crowded throngs of Eastern thoroughfares in former years stood little chance of an appreciative audience. Visualizing the fact that 70% of the nation's water powers lie in her domain, and that her interconnected systems stretch over distances equal to that from New York to Omaha or from New York to Jacksonville, Florida, men of the East can gain some fair conception of the vastness of vision that prevails here in the West. And so it is that when we view the electrification of a transcontinental railroad, the uses of electricity in pumping for irrigation, the development of mines, the application of electricity to every conceivable use upon the farm and in the home, and finally the high state of development of the average citizen in uses of electricity in the West, we may indeed say that the great convention in Pasadena this year promises unusual good things for the industry throughout the nation.

We of the West welcome men of our industry from all quarters of the nation. We trust that the buoyancy, enthusiasm and newness of life which prevail in a breadth of vision as vast and unlimited as is our district west of the Rockies, may have for each and every one of you a message of cheer, and an inspiration for future attainment that may carry our industry to even higher planes of accomplishment for the welfare and happiness of the human race.

Water Power Committee Report of the N. E. L. A.

The most powerful report ever compiled on the water power situation in America is that of the current committee's report on this subject for the National Electric Light Association convening at Pasadena, California. This report is published elsewhere in the Journal of Electricity in full. The report speaks volumes for the electrical industry . It has been compiled in a non-technical manner, setting forth valuable data on the present status of water power legislation, present tendencies in hydroelectric transmission and high voltage design, and winds up with a recommendation as to how the vast sums of money necessary for the industry may in the future be acquired. Forceful emphasis is given to this latter feature. From the statistics presented in the report one finds that something over seven hundred million dollars is required for investment in hydroelectric securities west of the Rocky Mountains during the next nine-year period.

Featuring in a pictorial way the status of present day developments in hydroelectric transmission, the committee has compiled an exhaustive map of the vast transmission systems located west of the Rocky Mountains. The cooperation of some fifty-eight companies has made possible this work. It represents a masterpiece in painstaking compilation and is a chart that will unquestionably prove invaluable to the industry as the best one to date setting forth interconnections of service and the possibility of long distance transmission of electrical energy. We commend the committee most heartily for this effective and splendid work that has thus been done. While the Journal of Electricity undertook the task of gathering this data for the map, it could never have been accomplished without the close and helpful cooperation of the water power committee and of the fifty-eight power companies west of the Rocky Mountains.

Contractor-Dealer Movement in the West

Much has, in former months, been said in a national way concerning the rapid rise of the Contractor-Dealer movement in the far West. For many years those who have been in close touch with the situation of electrical merchandising on the Pacific Coast have known that the ethics upheld and the method of organiza-

tion in vogue here in the West are of high quality. It is interesting to see how this movement continually advances. In 1912 the first real constructive seeds for future cooperative efforts were sown by the formation of Development Leagues and the like in the West. Then followed the Contractor-Dealer movement in city and state organizations, and as a final climax, the launching of what is today known nationally as the California Electrical Cooperative idea. Not only have stores been improved, new locations sought and the financial status of the Contractor-Dealer been very notably advanced, but the industry as a whole has prospered by closer and more coordinated efforts. And finally, service to the public has been bettered.

Then, too, the public is rapidly being brought to a clearer realization of the problems of the industry today through the vast advertising schedule that is now under way in the daily press throughout California. At the recent meeting in Stockton, California, of the California Association of Electrical Contractors and Dealers, a new advance was made in that hardware stores and department stores were brought into the conference. The straightforward and manly manner in which points at issue were argued, and the helpful attitude that prevailed throughout this meeting, show clearly the high status which the Contractor-Dealer movement in California has attained.

The Journal of Electricity, as a consequence, would feel it had not done its complete duty in chronicling the achievements of the past year unless at this time, when men of the industry are gathered in conventions in the West from all districts of the nation, it commended in highest terms the effective work of the Contractor-Dealer movement.

Reorganization in the N. E. L. A.

Many splendid new ideas have been brought into the National Electric Light Association's life during the current year, but none perhaps with such far-reaching possibilities as the reorganization work proposed in regard to the status of members and the status of various branches of the electrical industry in their relation to the National Electric Light Association. We commend most heartily the idea of giving broader representation to the manufacturers and jobbers, and would recommend that this representation be extended to electrical contractors and dealers. Perhaps the basis existing in the Pacific Coast Section N. E. L. A. may well be followed in the national organization. Here all branches of the industry sit upon the executive committee and the work has been found unusually harmonious, helpful and of a high educative value, both to the industry and to the public at large. The lessening of the dues for certain classes of membership and the raising of others, making it easier for the employes of the various branches of the industry to become affiliated with the National Electric Light Association, is to be commended. As the years roll by, it is demonstrated more and more clearly that one section of the industry finds it difficult to stand alone in the work that is to be performed. Consequently, the growing tendency to give broader and broader representation in the National Electric Light Association to other branches of the industry, outside of the central station group, is greatly to be commended. Unquestionably, as time goes on, these limitations will be still further removed until finally there will be one solidified cooperative industry throughout the nation, working through one well organized body, such as the National Electric Light Association, equally representative of all branches of the industry, and powerful in developing the industry within itself, and in forwarding service to the public which, after all, must always be the final aim of such an organization, if its work is to prove of permanent value.

Code of Ethics

All of the major associations and minor societies have codes of ethics for the guidance of their members. In some cases these codes have no real practical meaning because their provisions are not rigidly enforced, or because there is no machinery provided for their enforcement. It is a pleasure to note that the American Society of Mechanical Engineers proposes to have both a comprehensive code of ethics and means of enforcing it. The other engineering societies might do well to follow the lead of the Mechanical Engineers. In other branches of the engineering profession, particularly in the electrical branch, there is as great need for a rigidly enforced code of ethics as in any other. There are not so many occasions afforded in the electrical field as in the mechanical field where the provisions of the code of ethics might come into play, yet the dignity of the profession would be measurably stabilized were it public knowledge that the practices of all the engineers in the society were governed alike, and that only engineers of the very highest ideals could retain their membership in the association. Such a condition would tend to retain within the province of the societies the functions which the various states' engineer licensing laws would transfer to the state government.

The Revolving Electron Group

The study of crystals has made possible new and interesting discoveries in scientific and engineering matters during recent months. The paper by Professor Harris J. Ryan, given before a recent meeting of the American Institute of Electrical Engineers, brought out in a most interesting and conclusive manner how the submarine problem was virtually solved by studying the phenomena attendant upon crystal vibrations. Thus a crystal vibrating with enormous oscillatory motion was shown by him to produce sound waves that are far above the sensitiveness of the ear, and, as a conquence, are known as super-sonic vibrations. By means of such vibrations sound waves were produced, although inaudible to the ear, in such a way that echoes from submerged bodies, such as submarines, could be distinctly registered in the office of the observer, and so delicately that the location

of the submarine could thereby be ascertained. On another page of this issue is to be found the eleventh article on electrons and a new theory of matter. In the issue of the Journal of Electricity for April 15, 1920, was set forth an interesting study by Dr. A. C. Crehore. in his now widely read series of articles on "The New Physics." In this particular article Dr. Crehore discussed the average force between revolving electrons. By taking as a specific example the attraction between crystals, he develops a very interesting relationship in which he establishes the fact that the average force between two revolving electrons may be computed when the directions of the axes are fixed and specified as they are in a crystal. This enables us to picturize in a measure his new theory on the constitution of matter. Thus he shows, from the illustration of crystals discussed, that this particular class satisfies the condition that the weight of the crystal is independent of the orientation of the axes of the crystal, and thus makes possible a visualization of the action of the electron, which should give new and clearer meaning to this discussion of the constitution of matter and the New Physics which he has set forth in such an interesting and helpful manner.

Unification of Accounting Systems

Too long has our industry awaited the standardization of accounting systems. Great progress has been made along this line in the merchandising of electrical ware, but in a comparative study of privately owned and municipally owned power plants little data is available that may be relied upon as representing equality in comparison, either in justice to the privately owned plant or to the municipally owned plant. Many states of the Union have recognized the desirability of having unified accounting systems under direction of the regulatory bodies of those states both for privately owned and municipally owned power plants. Yet it is true that some of our most progressive and down-to-the-minute commonwealths have failed utterly in this regard. California, Michigan, Illinois, Vermont and Maine are glaring instances of this. In view of this crying need of the hour, the Journal of Electricity has conducted a nation-wide research to find out the exact status of this important question of unification of accounting systems for privately owned as well as municipally owned utilities. The results of this questionnaire that have come in from regulatory bodies in all the states, as set forth on another page of this issue, are highly illuminating. Practically unanimously, commissions the country over favor unification of this sort. An immediate campaign should be started to bring about an enabling act in all commonwealths not having unification standards at the present time, in order that open and above board comparisons—comparisons free from camouflage—may be made in the study of relative merits of privately owned as opposed to municipally owned utilities, and also that the splendid economic data available in various utilities, both municipally owned and privately owned, may have a common basis in comparison, and thus advance the industry as a whole in its economic supply of power to the public at large.

Sulphur in Fuel Oil

The increasing possibilities of Mexican petroleum being used in various steam-electric power plants throughout the West, brings up the discussion of the sulphur component in this particular oil. While sulphur has in itself a heat-giving component amounting to about 4,000 B.t.u. per pound, this extra heat value is not generally considered in itself of sufficient consequence to give sulphur importance as a fuel, in oil in which it may appear to an excessive amount. Sulphur, in burning, forms sulphur dioxide, which on combining with water forms sulphurous acid. Ordinarily corrosion does not occur as long as the temperature is above 212° Fahrenheit; hence corrosion of the boiler tubes is negligible as long as the boiler is kept in operation; but if a boiler is used for standby purposes, as many of our Western steam-electric power plants are, and is kept shut down a good deal of the time, there may be active corrosion of the tubes and drum shells.

Steel stacks are subject also to corrosion from this cause, especially the upper portion exposed to the weather where the cooling effect of the metal causes condensation of the moisture in the gases. Since these conditions are liable to arise in a more exaggerated degree than hitherto encountered, as a possibility of use of Mexican petroleum in Western power plants becomes more and more a reality, the subject of sulphur and its possible deleterious effects upon the steam generating equipment such as boiler tubes, drums and chimney stacks should be given more attention.

Automatic Regulation of Fuel Oil Plants

The thrilling days of war brought out more than ever before the necessity of improved economies in steam power plants. The good results to be obtained by careful and accurate metering in the power plant, combined with the constant study and skill of the trained engineer in combustion and steam engineering, brought forcefully to light the value of these as effective means for increasing economy. Through all this, however, there has been growing in recent months the insistent demand that power plants operated by fuel oil be, insofar as possible, automatically controlled. No other type of fuel, unless it be that of natural gas, lends itself so readily to delicate automatic control as does the power-plant burning fuel oil. The interesting and highly educative accomplishments of the new Cornelia Power Plant at Ajo, Arizona, recorded on another page of this issue, are illustrative of the delicate control that may be accomplished in fuel oil burning plants. In this plant it is seen that from three to four per cent is gained in efficiency by the use of automatically controlled fuel oil burners. The careful operation of this plant under Mr. Rogers, chief engineer, who writes the article above men-

tioned, shows the value of a trained hand in modern economic practice. Power plant operators throughout the West, and elsewhere in installations using oil as a fuel, will do well to study this question of automatic control and thus make possible the bringing about of economies thought otherwise unobtainable.

The Teredo and Foundations for Power Plants

Practically all our large steam electric power plants are located along the waterfront, or adjacent to large bodies of water. For many years past the teredo has been a common pest to the shipping industry in the wharves and waterfronts of the large seaports of the Pacific Coast, but, so far as the steam-electric industry is concerned, has been of little moment in the consideration of steam power plant development. The present drought, however, which has been of three years' duration in the West, has brought to light a new phase of the situation that may lead to interesting developments in the steam-electric industry, which in turn may help in the solution of the teredo problem.

The teredo, a very small organism that initiates its destructive work in piers and piles lining salt waterfronts, cannot exist in fresh water. After it has once become imbedded in a pile, it increases very rapidly in size, and in a short time by boring further into the pile it may become from 12 to 16 inches in length. The low water supply in such rivers as the San Joaquin and the Sacramento has brought salt water much farther upstream during the past two or three years than formerly, and as a consequence in places where the teredo used not to exist he today is most active. Along the waterfronts of these rivers vast destruction has been going on, and in a number of power plant foundations and boiler house installations the teredo has appeared to a very disastrous extent. It has developed that creosoted piles are not affected by the teredos, but if an uncreosoted stick of wood be nailed to a creosoted pile and the teredo once gets started in the uncreosoted piece, he will eat through to the creosoted portion of the adjacent pile and thus accomplish his destructive work.

There are many other interesting sidelights of this situation that may now be studied, and it is hoped that all possible consideration will be given to this destructive pest of the salt waterfronts. Since the foundation work and supports of circulating water supplies and and other installations connected with the modern steam-electric power plants are at stake, the power industry may well give considerable attention to this problem.

At a recent meeting of the civil engineers in San Francisco, at which over 125 members were present, the subject of the teredo came up for most earnest and thoughtful consideration. Here, then, is an opportunity for the mechanical and electrical engineer to help out in the solution of this dangerous situation that confronts foundation work, either in salt water or in fresh water where salt water at some period may become available.

Standardizing Valuation Theories

The confusion which has resulted from the diversity of theories of valuation held by our courts and engineers is now being acutely felt in the insufficient rates and fares which are demanding revision in all branches of industry and in all parts of the country. Where proper allowance for replacement has not been made —and unfortunately precedent has too often led both courts and engineers to accept an insufficient rate base upon which returns are allowed—the public now finds itself in the position of having accepted service for years below cost and of having to face the situation of either allowing a return sufficient to make up for the losses of this period or of providing substitutes for businesses which can no longer carry on in the face of increased costs and wage scales. The condition of electric railways is fully as serious as this would indicate, and may be looked upon by the somewhat more fortunate branch of electric service corporations as an example of where such a policy of malnutrition may lead.

The engineer is the authority to whom we should look for the stand which shall clarify the situation. In spite of the confusion of thought which has complicated the situation, the principles which underly this problem of valuation and the determination of the rate base are exact, and capable of logical determination. The matter has been brought up by J. R. Bibbins for consideration at the A. S. M. E. convention at St. Louis, and should bring forth discussion and subsequent society action which should do much to clear up the deplorable lack of unanimity among engineers. It is to be hoped that the stand taken at this time will be sufficiently farsighted and scientific in its principles as to avoid the pitfalls of arbitrary allowances to cover deficiencies which should not exist and which are susceptible of varying interpretations in the name of justice. In any case, a united stand on any ground will soon win over the recognition of the courts which are themselves dissatisfied with the present state of chaos.

JUNE 1st—CONVENTION ECHO NUMBER

Reports of sessions, high lights of the business and entertainment features—a complete and indispensable review of the three big conventions of the year:

Electrical Supply Jobbers' Association	**Del Monte, May 12-14**
Pacific Coast Section, National Electric Light Association	**Pasadena, May 17**
National Electric Light Association	**Pasadena, May 18-22**

WHERE SEVENTY PER CENT OF THE NATION'S WATER POWER WAITS DEVELOPMENT

To the mountainous topography of the far West is due the fact that two thirds of the nation's water power is located in this region, 70% of the undeveloped water power being found west of the Rocky Mountains. The scene shown is that of the headwaters of the Skagit River, on which Seattle is developing additional power.

Developing National Water Power

(The following report by the Water Power Development Committee of the National Electric Light Association is undoubtedly the most comprehensive discussion and compilation of such data ever attempted by the electrical interests of the country. The figures used in the tables and curves are the best obtainable from the most reliable sources, practically all the leading engineers and executives of the West and many of those of the eastern power companies having been consulted.—The Editor.)

In the preparation of this report and in the collection and compilation of the data contained herein, the Committee wishes to acknowledge and express its appreciation of the assistance given by prominent Central Station officials throughout the country and others closely affiliated with the industry.

Particular credit is to be accorded Mr. Robert Sibley, editor of the Journal of Electricity and Pacific Coast editor Electrical World, and to members of his staff, for their hearty cooperation in the preparation of this report, the map and the compilation of the western data here presented.

Growing Importance of Water Power Development.

The imperative demand of a water power development schedule embracing in large measure the great unused natural resources of the country is no longer doubted. Heretofore there has perhaps been no better constructive work done in behalf of water power legislation and development than has year after year been accomplished by investigations, compilations and discussions in meetings of the National Electric Light Association. The technical press of the country, the engineering and scientific societies, and the formal reports of this organization have fairly well covered the national aspect of the question of water power development. We shall, as a consequence, not endeavor to touch upon the broad general fields of investigation undertaken by previous committees, but we shall take advantage of the peculiar setting of the National Electric Light Association Convention this year at Pasadena, California, to give prominence to the conditions of water power development prevailing west of the Rocky Mountains, which we believe to be of such importance as to call forth the interest and earnest consideration of this body. But while these discussions are in a certain sense local, let it be understood that they are cited for the purpose of giving instances near at hand for verification rather than to set up for emphasis the individuality and peculiarities of water power problems in the far west.

Need of Fuel Conservation in West

Taking then the instance of the eleven far western states, as a specific example, we find by careful survey an unusual situation. Due to delay of the construction program in power development, for some two or three years while the nation was in the throes of war, this section of the country finds itself today facing a serious situation, ranging from an actual shortage of power to meet present demands, as in California, to an impending shortage to meet growing demands, as in Oregon and Washington. With increasing possibilities of coal shortage, the continual rise in price of oil, and the economic desirability of early electrification of steam railroads, the urge for increased water power development in the far west becomes imperative. Not only are many industries already existent dependent upon electrical development, but it is believed that industrial growth on the Pacific Coast and electrical development are interdependent.

And if this is true in industry, surely it has proven true in agriculture. Vast areas of arid and semi-arid western lands that may be termed empires, have been converted into fertile districts under electrical pumping of water that would be impossibilities without its use.

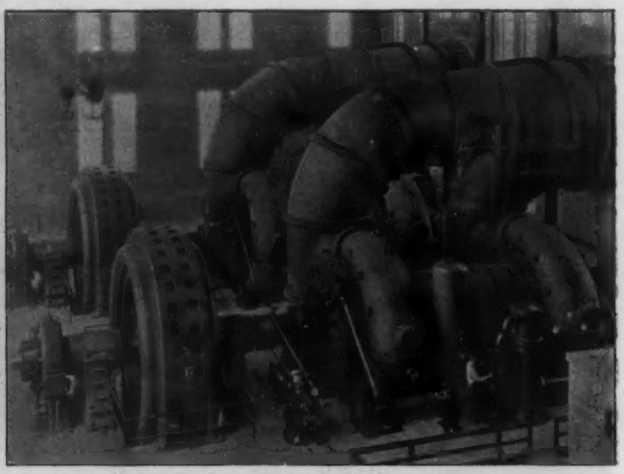
Water Power in Eastern States

To a lesser degree the further development of the water power in the eastern states calls for the serious and earnest attention of not only the public utility operators and users of large blocks of power but also that of the conservationists and the government itself.

While the potential water powers of the eastern and central states, as a whole, can never be expected to meet more than a minor part of the present total power requirements of those states, which is approximately 96,000,000-hp., as against

STORAGE POSSIBILITIES IN IDAHO

Controlling works in the north channel of the Spokane River at Post Falls, Idaho, where flood waters are impounded during the winter season, thus permitting a greater power development on the river below. It is probable that the use of storage would increase the available horsepower for the United States from about 60,000,000 to 200,000,000.



LARGE UNITS CHARACTERISTIC OF THE WEST

Two of the four 14,000-kw. generators of the Long Lake Station of the Washington Water Power Company, direct-connected to 22,500-hp. hydraulic turbines operating under 168-ft. effective head. In spite of the large hydroelectric developments of the state, the water power possibilities of Washington have hardly been scratched.

approximately 18,000,000-hp. of maximum potential water power possible of development in those states, the trend of labor and transportation conditions makes imperative the utmost co-ordinated development and application of hydroelectric power wherever available.

Much might also be said of this need in the eastern states purely from the standpoint of conservation of coal. Of the 542,000,000 tons of coal used in this country in 1915, approximately 267,000,000 tons were used for power purposes and 275,000,000 tons for heating. The efficiency at present obtainable for the latter use is approximately 50%, whereas for the former it approximates but 5%. It is therefore obvious that in so far as possible the remaining coal supply of this country should be relieved of its power application and conserved for its more efficient heating application.

Altho most desirable for the protection of future generations, it is of course not to be expected that water powers will be developed, at least in the near future, under conditions and in locations where an abundance of cheap coal or other fuel results in an economic advantage in favor of steam generation, but the time will no doubt come when the utmost development of all water powers will be enforced, if necessary, in the interests of conservation of fuel for heating purposes.

There are, however, at the present time numerous undeveloped water powers in the eastern states which can successfully compete with coal generation, and these undeveloped water powers are only awaiting favorable legislation to pave the way for their development.

Necessity for Legislation

Present economic conditions affecting such developments in various of the eastern states are reflected in the replies received from prominent eastern central station men in answer to inquiries along this line. These replies are presented in full in Appendix "A" attached to this report. They are from representative men in the electrical industry and throw considerable light on the trend of opinion of those who are facing the present condition of power development.

As will be noted the general trend of these replies is lack of suitable legislation and the establishment of a fixed policy on the part of the Federal Government in the granting of permits for the development of water power on federal reserve lands and on navigable streams. Some very interesting comments on other parts of the problem are also given.

Federal Legislation and the West

Existing federal legislation as distinguished from state legislation in so far as it directly affects water power development, relates to the use by power companies of navigable waters and of public lands and reservations. Federal enactments concerning navigable waters are of general application throughout the United States, and do not affect or interest one section of the country more than any other. Federal legislation governing the use of public lands and reservations, however, is of primary importance to the western states in which lie nearly all the public lands and in which approximately 70% of the undeveloped water power of the nation is found.

Priority of Navigation Rights

From the date of the Act of May 18, 1796, declaring that "All navigable rivers, within the territory occupied by the public lands, shall remain and be deemed public highways," down to the present time, Congress has zealously guarded the rights of navigation and from the Congressional Acts and the court decisions construing the same we must conclude that the right of the public to use the waters of navigable streams for navigation is considered paramount and superior to all other rights to use such waters; and where such other uses tend to injure or destroy the navigation of bodies of water naturally navigable, such uses must give way to the rights of navigation. To this superior right developments of power on navigable streams must yield.

By virtue of the Act of March 3, 1899 (9 Fed. Stat. Ann. p. 81) and the Act of June 23, 1910 (9 Fed. Stat. Ann. p. 95) no dam in navigable waters may lawfully be constructed until there has been obtained the consent of Congress and the approval of the plans therefor by the Secretary of War and the Chief of Engineers, except that dams in waters, the navigable portions of which lie wholly within the limits of a single state, are permitted if authorized by state legislation and the location and plans are approved by the Chief of Engineers and the Secretary of War. The necessity of obtaining the consent of Congress in the one case and of a state legislature (if legislative authority of general character does not already exist) in the other, constitutes an obstacle which, if not insurmountable, at least operates to retard developments on navigable streams.

The Act to create a Federal Power Commission, now under consideration in Congress, would remove this obstacle by vesting in the Commission the power to issue licenses for the construction of dams in navigable waters, the plans of the dam or other structure to be approved by the Chief of Engineers and the Secretary of War if the navigable capacity of the stream is affected by the project.

The existing Act to regulate the construction of dams authorized the Chief of Engineers and the Secretary of War to impose conditions and stipulations deemed necessary by them to protect the government's interests, which may include the requirements of constructing locks, etc., without expense to the United States; of conveying to the United States free title to land needed for locks or other navigation structures when Congress authorizes the construction of the same in connection with the dam, and of granting to the United States free power for building and operating such structures. The Chief of Engineers and the Secretary of War are required, as part of such conditions and stipulations, to provide for improving and developing navigation, to fix such charges as may be sufficient to restore conditions with respect to navigability, or reimburse the United States for doing the same, and for further expense incurred by the United States, including cost of investigations necessary for approval of plans and of supervision of construction; to fix and collect just charges for the privilege granted to all dams constructed under the Act which shall receive any direct benefit from (a) the construction, operation and maintenance by the United States of storage reservoirs at the head waters of any navigable streams or (b) from the acquisition, holding and maintenance of any forested watershed or lands located by the United States at the head waters of any navigable stream, wherever such shall be, for the development, improvement, or preservation of navigation in such streams in which such dams may be constructed.

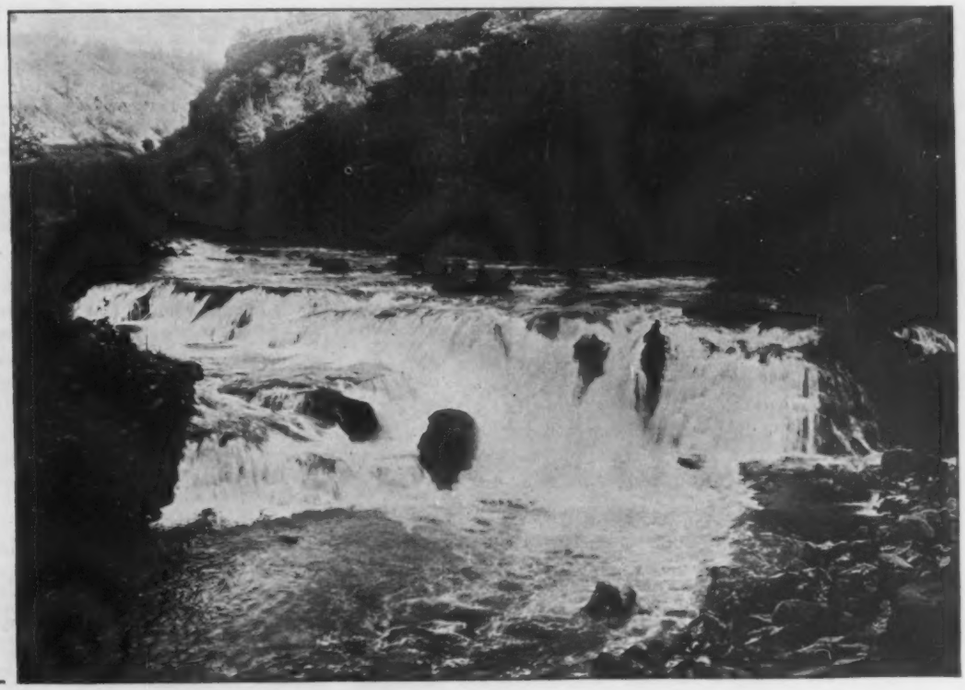
The existing Act also provides for forfeiture for noncompliance, after reasonable notice, with the Act, stipulations, or conditions; also for revocation by Congress when necessary for public use, with payment of the reasonable value of the dam and works to be determined by agreement or by condemnation proceedings on failure to agree upon the value. The term of the permit is limited to fifty years.

The existing federal legislation as to power structures in navigable streams has not been subjected to the severe criticism directed against the government's policy in regard to developments on the public domain. But two answers to the questionnaire sent out suggested that federal control or regulation of navigable streams constituted an influence retarding the development of water powers. (Minnesota and New York.)

Power Development on Public Lands

Existing Federal laws relating to power developments on public lands and reservations have unquestionably operated to hamper and restrict, if not almost wholly prevent, such enterprises. The creation of forest reserves and the executive withdrawal of power sites would not have deterred such projects if Congress had pursued a fair and liberal policy in recognition of the economic benefits resulting from such developments. The Acts of Congress, however, provided no definite term of use, were meager in detail, and left too much to departmental regulations with the result that financial support of meritorious projects could not be secured. The lack of certainty of tenure, the imposition of excessive rental charges, the regulation of rates for service, the possibility of cancellation of the permits, the cumbersome procedure, the lack of authority of local officials, unreasonable delays in obtaining rulings and action, absence of centralization of authority—it being necessary in some instances to deal with both the Interior Department and the Department of Agriculture—and the injustice of the regulations when but a minor part of the project was on public lands, all tended to make a development on the public domain unattractive to both investors and operators, especially if at all in actual or potential competition with other power companies owning their plants in fee simple.

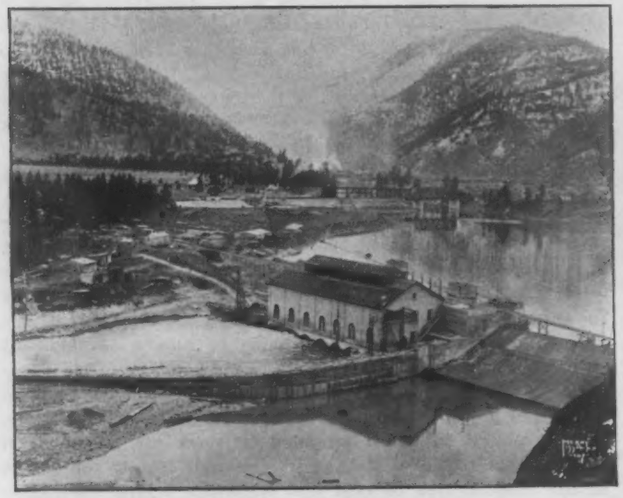
A policy no doubt intended to work for conservation actually resulted in waste and irretrievable loss to the extent of the consumption of coal and oil which might have been avoided by the use of water. Ideas concerning conservation are not now so hysterical and there appears to be a better understanding of the needs of power companies and the conditions under which developments may be made on public lands, and a clearer recognition of the economic necessity of making such developments and the economic good resulting to the general public from them, with the prospect of soon receiving from Congress legislation which will be more liberal. The fear of many well-meaning persons that water powers on the public domain would be developed by grasping capitalists for the purpose of exploiting a defenseless public, is now almost entirely dispelled by the general appreciation of the power of public service commissions to regulate rates justly as between the producer and the consumer.



One of the big water power developments of the West where 350,000 hp. are to be developed, has been begun by the Pacific Gas & Electric Co. on the Pit River, California. A feature of this project is to be a 220,000-volt transmission line into San Francisco.

State Laws of Navigable Streams

State laws relating to the construction of dams in navigable waters controlled by the state and to the use or acquisition of lands needed for the construction of power plants and of transmission lines seem to be generally satisfactory. In Pennsylvania, however, power companies are embarrassed by



ONE OF THE MONTANA DEVELOPMENTS

The Bonner Hydroelectric Plant of the Missoula Light & Water Company of Missoula, Montana. Montana has developed but 9.4% of its available water powers.

not having the power to appropriate property (eminent domain) necessary for transmission and distribution lines; and in New York, where the economical development of power possibilities cannot be carried out without regulation of flow by reservoirs; it appears that under the present constitution of that state such lands cannot be acquired by condemnation. In New York also the larger portion of undeveloped power is in, or connected with, state forest reserves which cannot be entered for practical purposes without a change in the state constitution.

Diversity of State Legislation

The right to use, or appropriate, the waters of any stream, whether navigable or not, depends upon the law of the state wherein the stream is located. Congress has never assumed to regulate the use of water except as navigation is affected, providing in the Right-of-Way Acts that waters shall remain governed by state law. In the Forest Service Act of June 4, 1897 (9 Fed. Stat. Ann. p. 589) it is declared that "all waters on such reservations may be used for domestic, mining, milling or irrigation purposes, under the laws of the states wherein such forest reservations are situated, or under the laws of the United States and the rules and regulations established thereunder." The Forest Service has not attempted to avail itself of this last clause, but takes the position, as yet, that the states shall control the waters. Control of access to streams, however, would seem in fact to be control of the waters of the stream.

We find that in the exercise of the power of each state, by constitutional provision, by legislative enactment, or by court decision, to adopt such a rule governing the waters flowing or standing therein as it sees fit, the various states as to their water laws may be grouped as follows:

1. Those which have adopted the common law of riparian rights only, as has been done in the eastern states.

2. Those which have rejected the common law of riparian rights and adopted the Arid Region Doctrine of appropriation. This is known as the Colorado Doctrine and is in force in Alaska, Arizona, Colorado, Idaho, New Mexico, Nevada, Utah and Wyoming, and partially in Nebraska, Oregon, Texas and Washington.

3. Those which have retained the common law of riparian rights and at the same time adopted the Arid Region Doctrine of appropriation, thus having a dual system. This is known as the California Doctrine, and is in force in California, Kansas, Montana, North Dakota, Oklahoma, South Dakota, and partially in Nebraska, Oregon, Texas and Washington.

State Water Codes

A number of states have adopted extensive water codes based on the law of appropriation but recognizing vested rights, whether riparian or otherwise. These states number Colorado, California, Idaho, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, Texas, Utah, Wyoming and Washington.

These states have constitutional or legislative declarations that unappropriated waters are "The property of the state" or "the property of the public", terms held synonymous, in the making of which the state acts in its sovereign capacity only and not as proprietor or owner of the water. Such dedication is, of course, subject to the rights of the United States (1) as owner of public lands or reservations bordering on streams to the continued flow of their waters so far at least as may be necessary for the beneficial uses of the Government property and (2) to secure unimpaired the navigability of all navigable streams.

The water codes referred to contain administrative provisions too detailed to enumerate.

Influences Retarding Development

The questionnaire answers show, in the main, reasonable satisfaction with existing state laws. In California the combined system of riparian rights and appropriation is found embarrassing. In that state storage is necessary, and this results in bringing the water to the riparian owner in different quantities and at other times than it would come in the course of nature, necessitating the obtaining of consent agreements from riparian owners. The doctrine of riparian rights is protected by the constitution and cannot be abolished by the legislature.

The answers received to the question "What influences are retarding the development of water powers in your state?" may be summarized as follows:

1. Influences of a physical character:
   - a. Variable stream flow or lack of continuous supply; Ind., Kan., Penn., Dist. of Col.
   - b. Low heads: Neb., Penn.
   - c. Lack of impoundage: Penn.
   - d. Climatic conditions, such as drought and freezing: Ind., Neb.
2. Influences of an economic character:
   - a. Cheap fuel: Ind., Kan., Penn.
   - b. Market conditions: Md., Nev., Wash., Ark., Ky.
   - c. Cost of money: Ga., Ind., Ky.
   - d. High cost of development: Md.
   - e. High cost of lands overflowed: Iowa.
   - f. Refusal of investors to finance developments under unattractive terms of government permit: Colo.
3. Influences of public policy:
   - a. Tendency of regulatory commissions to keep down service rates, Ga.
   - b. Municipal competition: Wash.
   - c. Conservation policies: Calif.
4. Influences of legislation or lack thereof:
   - a. Inertia of Congress: Calif.
   - b. Government withdrawals: Mont.
   - c. Lack of right of eminent domain: N. Y., Penn.
   - d. Embarrassment resulting from doctrine of riparian rights: Calif.
   - e. Lack of co-operation between states as to interstate streams, especially in relation to the construction in one state of reservoirs which benefit water users in another state: Mass.
   - f. Restrictions as to use of waters of international boundary streams: N. Y.
   - g. Restrictions as to entry on state forest reserves: N. Y.

In answer to the question "What, if any, legislation should be enacted to make available for development the water powers of your state?", answers received from practically every western state specified the passage of the water power bill now pending before Congress. The retarding influences above summarized indicate the character of desired or needed legislation in the different states from which answers were received. Additional answers received were in brief as follows:

1. Placing it beyond the power of any regulatory body so to limit the earnings of utilities that they cannot finance for future needs of their territory served: Calif:
2. Relieving the rate fixing body of its function of "representing the people": Calif.
3. Extending the time when municipalities under Water Commission Act may take over an appropriation for electric power purposes from 20 years to the same period as in Federal permits: Calif.
4. Repealing that portion of the state law which requires payment to the state of ¼ of 1% of the annual gross revenues for the first ten years and ½ of 1% thereafter: Ark.

5. Authorizing utilities to change their rates, either upward or downward, the changed rates to become effective, subject to review by the the Commission on complaint, coupled with a disposition on the part of the public and the authorities to permit rates sufficient to attract capital into the enterprise: Ga.

6. Financial state aid for the construction of the dam, head race and tail race: Ind.

Pending National Legislation

The most important national legislation to be expected in the near future affecting water power development, is the

CONSTRUCTION IN THE NORTHWEST

An important development now being carried out by the city of Seattle on the Skagit River. The picture shows the diamond drill at work on the Ruby Dam site.

final passage of the so-called "Water Power Bill" (HR-3184), which was first passed by the House, later amended and passed by the Senate in its amended form, and which is, at the time of writing this report, in the hands of a Joint Conference Committee with good prospects of an early passage.

This bill is the final result of over ten years of controversy and exhaustive hearings and discussions before various committees of Congress in an endeavor to provide a law establishing the conditions under which, and the necessary administrative machinery by which, the water power resources of the country might be developed under terms sufficiently attractive to capital and yet properly safeguarding the public interests.

Briefly the essential features of this bill as amended by the Senate provide for the following:

A. The creation of a federal power commission, consisting of the Secretary of War, Secretary of the Interior, and Secretary of Agriculture.

B. The detailing of an officer of the U. S. Engineering Corps to serve the Commission as executive secretary and engineer for the Commission.

C. The Commission is authorized to make investigations of and to collect and record data in regard to water resources of the country, water power surveys, industries requiring power, etc.

D. The Commission is authorized to issue licenses not exceeding a term of 50 years, the development to be subject to purchase by the government at the end of that period, with due regard given to severance damages.

E. Provision is made for the payment of permit fees annually by the holders of the permits, such fees to be of sufficient amount to cover the administrative expenses but in no case to exceed 25 cents per horse power.

F. The establishment of rules and regulations governing the conditions under which the act is to be administered by the Commission.

G. Provision is made that the rates and conditions of service of public utility companies operating under permits provided for in this act, are to continue under the jurisdiction of the state public service commission, or in the absence of such a commission, to be applied under the jurisdiction of the Federal Power Commission.

While this bill is perhaps not all that might be desired it will no doubt furnish a sufficiently practical and acceptable basis for the early promotion of various projects now awaiting such legislation.

It is quite possible the bill, with some final modifications, may have become a law by the time this report is presented to the convention. When it does finally become a law, early attention from all concerned will naturally be directed to the broad policy of administration of the Act and the operating details to be established therefor.

Permanent Committee on Water Power Suggested

The utmost co-operation between the Federal Power Commission to be established and the electric power industry should be inaugurated and encouraged. Particularly does this apply in the formulation and application of the rules and regulations to be established by the Power Commission in accordance with the Act. On these rules and regulations and on their interpretation and application will depend to a large extent the ultimate success or failure of the purpose of the Act, i. e., the development of the country's water power resources.

It is essential that the electrical industry act as a unit in co-operation with the Power Commission, and, as a means to that end, it is here proposed and recommended to the N.E.L.A. that a permanent committee be appointed to represent the industry in its relations as a whole with the Federal Power Commission.

The work of this committee, if carried along the lines here contemplated, should be of inestimable value not only to the industry but to the Federal Power Commission and to the country at large. It is earnestly hoped, and confidently expected, that the Federal Power Commission will be receptive to such co-operation on the part of the electrical industry and will welcome suggestions and recommendations from men, the broad experience of whom in the financial and engineering phases of water power development, will be of great value to the Commission in the development and application of rules and regulations which will be practical and workable as well as sufficiently adequate to meet the restrictions contemplated by the Act.

Present and Potential Water Powers

The present and potential water powers of the United States have been estimated at various times during the past

SKAGIT RIVER DEVELOPMENT

Diablo trail bridge at the damsite, Skagit River Project which is to supplement the present system of the city of Seattle. This is an example of the construction work now under way in all parts of the west.

12 years. The report of the U. S. Geological Survey of 1908 is embodied in the report of the National Conservation Commission, February, 1909 (see Water Supply Paper No. 234 of

the U. S. Geological Survey). The data set forth therein form the basis for a number of subsequent reports on the subject. Explanation is given in considerable detail of the methods by which the estimates of potential and developed water power were made and the figures given, with the more recent adjustments, and additions made thereto, are the most authoritative data available at the present time. In giving consideration to these figures it must of course be borne in mind that calculations on potential water power are essentially approximations only as the ultimate development of any water power project is dependent on a large number of factors such as possible storage development and practical availability of overflow lands, which is impossible of accurate determination in such a preliminary survey and estimate. Even the data on developed water power must necessarily be estimated to some extent, although the Bureau of the Census has from time to time compiled statistics on developed water power, which are so complete as to leave little margin requiring determination by estimate.

For the purpose of analyzing the general power situation, however, the estimates of developed and potential water power, which have been made, are fully sufficient and adequate.

The basic report of the U. S. Geological Survey previously mentioned has been amplified and readjusted from time to time as more recent data became available, and the latest reliable estimates, both of developed and undeveloped water power in the United States, may be obtained from a joint consideration of the U. S. G. S. estimate of 1915 and the estimate recently made by the Electrical World as of January 1, 1920. The latter has used as its basis the 1915 estimates of the U. S. G. S. and is the result of a careful study of water power reports issued by engineers of the Geological Survey since 1915, reports of other federal departments, state conservation and surface water reports, as well as private engineering reports. Corrections to the Geological Survey estimate of 1915 have been made based upon these various later reports.

This statement gives both the U. S. Geological Survey estimate of 1915 and the more recent estimate of the Electrical World as of January 1, 1920. The two are not materially different and for purposes of comment on the figures shown, reference will be made only to the figures of the more recent Electrical World estimate.

Development in Western States

In an examination of this tabulation attention is first attracted to the fact that 68.6 per cent of the potential maximum horse power of the United States lies in the western states (the Pacific and Mountain States of California, Oregon, Washington, Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah and Wyoming). In connection with these percentages it is also of interest to note that, of the total maximum potential water power of the United States, 74.3 per cent represents undeveloped horse power coming under federal jurisdiction, i. e., lying on federal reserve lands or on navigable streams wherein federal permits are required. In the western states 94 per cent of the maximum potential water power is in this class. These percentages are from "Facts About Water Power" prepared and published by the Executive Committee of the Water Power Development Association. In other words, practically all of the future developments of water power in the western states (covering approximately 70 per cent of the total potential water power of the country) will be dependent upon federal action in the matter of issuance of workable permits for the development of these projects.

It is also of considerable interest and significance to note that, in the United States as a whole, only 16.6 per cent of the maximum potential water power has been developed up to the present time. For the western states alone this proportion is only 6.5 per cent. In other words, the maximum potential water power of this country has, to date, been developed only to the extent of one-sixth of the total possible, and, in the case of the western states, only about one-sixteenth of the possible water power has been utilized.

The Factor of Storage

While it is true that the figures here given for potential maximum water power include water powers which are not at the present time within the range of economic development, it is also true that these figures do not include the additional water power which would be made available at some of the power sites by the development of seasonal storage reservoirs. This latter feature of water power development is a factor which is not susceptible of a definite estimate from the data at present available. The values here shown for potential maximum horse power represent values of six months' continuous horse power, i. e., the minimum horse power available for the maximum six months' flow during the cycle of a year, without consideration of the possibilities of seasonable storage reservoirs. While, as previously stated, no definite estimate can be made of the total additional water power which might be made available by the inclusion of seasonal storage, some idea can be obtained of the effect of such storage on the total potential water power available. It has been roughly approximated, from the limited data available, that something like 200,000,000-hp. would represent the possible maximum potential horse power with maximum storage facilities developed and utilized, as compared with approxi-

TABLE NO. 1—WATER POWER OF UNITED STATES

States	U. S. GEOLOGICAL SURVEY ESTIMATE OF 1915 — POTENTIAL MAXIMUM: Horse power	Per cent of total potential of U. S.	DEVELOPED: Horse power	Per cent of total developed of U. S.	Per cent of max. potential of district	ELECTRICAL WORLD ESTIMATE, JAN. 1, 1920 — POTENTIAL MAXIMUM: Horse power	Per cent of total potential of U. S.	DEVELOPED: Horse power	Per cent of total developed of U. S.	Per cent of max. potential of district
Western States (Pacific and Mountain)	42,850,000	67.5	2,560,000	29.7	6.0	40,701,000	68.6	2,664,990	27.1	6.5
New England States	1,921,000	3.0	1,441,000	16.7	75.0	1,951,000	3.3	1,506,500	15.3	77.2
Atlantic States	10,922,000	17.2	3,019,000	35.0	27.7	9,348,000	15.7	2,952,850	30.0	31.6
Central States	7,797,000	12.3	1,589,000	18.6	20.4	7,360,000	12.4	2,699,200	27.6	36.7
TOTAL U. S.	63,490,000	100.	8,609,000	100.	12.7	59,360,000	100.	9,823,540	100.	16.6

TABLE NO. 2—WATER POWER OF WESTERN STATES

States	U. S. GEOLOGICAL SURVEY ESTIMATE OF 1915 — POTENTIAL MAXIMUM: Horse power	Per cent of total potential of U. S.	DEVELOPED: Horse power	Per cent of total developed of U. S.	Per cent of max. potential of state	ELECTRICAL WORLD ESTIMATE, JAN. 1, 1920 — POTENTIAL MAXIMUM: Horse power	Per cent of total potential of U. S.	DEVELOPED: Horse power	Per cent of total developed of U. S.	Per cent of max. potential of state
California	9,250,000	14.6	910,000	10.6	9.8	9,250,000	15.6	942,000	9.6	10.2
Oregon	7,000,000	11.0	280,000	3.2	4.0	7,100,000	12.0	248,000	2.5	3.5
Washington	9,500,000	15.0	570,000	6.6	6.0	9,500,000	16.0	361,000	3.7	3.8
Arizona	2,000,000	3.1	34,000	0.4	1.7	1,698,000	2.8	67,600	0.7	4.0
Colorado	2,000,000	3.1	190,000	2.2	9.5	1,850,000	3.1	238,000	2.4	12.8
Idaho	6,000,000	9.4	160,000	1.9	2.7	6,110,000	10.3	89,400	0.9	1.5
Montana	4,500,000	7.1	250,000	2.9	5.6	4,250,000	7.1	395,000	4.0	9.4
Nevada	250,000	0.4	33,000	0.4	13.2	250,000	0.4	55,500	0.6	22.2
New Mexico	300,000	0.5	3,000	.....	1.0	326,000	0.5	650	.....	0.2
Utah	1,250,000	2.0	125,000	1.5	10.0	1,320,000	2.2	263,000	2.7	19.9
Wyoming	800,000	1.3	5,000	.....	0.6	750,000	1.3	4,840	.....	0.6
TOTAL WESTERN STATES	42,850,000	67.5	2,560,000	29.7	6.0	40,701,000	68.6	2,664,990	27.1	6.5
TOTAL U. S.	63,490,000	100.	8,609,000	100.	12.7	59,360,000	100.	9,823,540	100.	16.6

mately 60,000,000-hp. which, in the above tabulation, is considered as the potential maximum horse power available.

East of the Rockies

In the case of the central and eastern states, particularly the New England states, it is shown that a comparatively large portion of the potential water horse power has been already developed. In the case of the New England states the high percentage of 77.2 per cent already developed shows that little additional water power development is to be expected in this district. Future developments here will consist chiefly in the more efficient utilization of the water powers already developed. Such increase in efficiency will be accomplished largely by co-ordination and unification into a comprehensive system of the numerous small developments which have been established here for a number of years. More will be said on this subject in another part of this report.

Comparative Developments in West

Inasmuch as the western states represent such a very large proportion of the potential maximum water horse power of the country, interest is naturally directed to this group. Table 2 shows in detail by states the potential maximum horse power and the developed horse power of this group.

Particular attention is directed at this point to the developed horse power of these western states. Using again the Electrical World figures, California is shown well in the lead with a present development of 942,000-hp., which is 10 per cent of the entire developed water horse power of the United States. It is, however, only 10.2 per cent of the maximum potential water power possibilities of that state. While Washington shows the largest maximum potential water horse power of any state in the Union it ranks among the western states below both California and Montana in the amount of developed water horse power, showing only a development of but 3.8 per cent of its potential maximum possibilities and only 3.7 per cent of the total developed water horse power of the country. Oregon also shows wonderful potential water power possibilities, and, up to the present time, only a very low percentage of development, 3.5 per cent of the maximum possibilities of the state. These figures clearly show that, although the West has already developed some remarkable water power projects and is well up in the lead in the development of large interconnecting networks of transmission systems, the water power development in this section is however but begun.

Western Transmission Lines

With this report is exhibited a map of existing western transmission lines. A glance at this exhibit, with a realization of the territory covered, gives a conception of the great distances involved in western transmission. Interconnections between systems have completed the circuit until there is now an unbroken connection from Medford, Oregon, on the north, down to Los Angeles on the south, thence to the Mexican border line, and from Los Angeles on northward into Nevada —an extent of over fourteen hundred miles, a distance as great as that from New York to Omaha, or from New York to Jacksonville, Florida. The interconnection in the Northwest that exists in the operation of the Chicago, Milwaukee & St. Paul Railway, which is now electrified over the Cascades and Rocky Mountains, gives another instance of long distance interconnected service; for this railroad from Harlowtown, Montana, on the east, to Seattle on the west, will make a solid chain of copper of some eight hundred and three miles when the remaining power interconnection of one hundred and fifty miles in eastern Washington is completed during the forthcoming summer.

Centers of Activity

Looking again at this map it is observed that the network of transmission usually clusters about some great city or industrial center. Thus we have the power lines of the Southern California Edison Company coming down to Los Angeles from Big Creek, a distance of two hundred and forty miles north, at a voltage of 150,000; together with a number of other high-powered lines, which come into Los Angeles from various distances. The area served by this one company is so vast that were it superimposed upon the two hundred and forty operating companies in New England, this one company would outdo them in extent of area served. On to the north the district in and about San Francisco constitutes another interesting phase of development wherein will be found even greater areas served than that by the Edison Company. Here the Pacific Gas & Electric Company and the Great Western Power Company combine in an unusually large system. In fact, during the war period, this interconnected system with the Sierra and San Francisco Power Company, comprising the three companies then serving San Francisco, which as a war measure were placed under one operating management, had the greatest power output ever recorded in the United States up to that time, overtopping even that of the Commonwealth Edison Company of Chicago. The interconnected companies feeding San Francisco in the war period generated over 1,500,000,000 kilowatt hours of energy, while the Commonwealth Edison Company generated something less than 1,500,000,000 kilowatt hours during the same period. No more extensive system of distribution of electric service is to be found than that in and about the San Francisco district.

These statistics from April 1, 1917, to March 31, 1918, are as follows:

Pacific Gas & Electric Company, Great Western Power Company, Sierra & San Francisco Power Company	1,500,408,765
Commonwealth Edison Company	1,488,080,000
Niagara Falls Power Company	1,188,221,770
Ontario Power Company & United Electric Light and Power Company	954,913,584
Montana Power Company	947,732,014
Montreal Light, Heat & Power Company	946,832,817
Hydraulic Power Company	871,563,138
Toronto Power Company	800,638,000
Southern California Edison Company	794,687,405

Farther up to the north and east, about Portland, Oregon; Seattle and Spokane, Washington; Butte, Montana; Boise, Idaho, and Salt Lake City, Utah, are to be found similar high tension networks and vast distribution systems of hydroelectric energy serving in the development of agricultural empires and industrial centers in the embryo.

CONSTRUCTION UNDER WAY IN IDAHO

The Idaho Power Company is now installing a 6000-kw. turbine in its Thousand Springs Station. The increased demand for power during the last year in this region has been unusually great and is expected to continue.

Magnitude of Engineering Problems

In any discussion wherein actual development of western water power is to be considered, it must not be overlooked that the topography of this region frequently necessitates the solution of problems unprecedented in engineering practice. It is as a consequence, timely and to the point that mention be made at this time of some of these feats in engineering that have been accomplished in the far west, in order that

SAN FRANCISQUITO PLANT

No. 1 San Francisquito Plant of the Los Angeles Bureau of Power and Light. Construction on the No. 2 Plant is now under way and it is expected that a 20,000-kw. unit will be ready this summer.

we may get a clearer conception of the vastness of the problem involved and what has been accomplished in the development of hydro-electric energy throughout the West.

A Popular Misconception of Waterpower in the West

Waterpower development in the West, in the main, has not followed the popular conception of such enterprise. The general conception of a power project involves the harnessing of a waterfall, such as Niagara, or of lesser magnitude, as the case may be. The typical western development usually involves no waterfall of any size. The power project is located in a mountain canyon where either a reliable minimum flow of the stream may be found the year round, or else storage is developed, above the point of such diversion. Such a power site may not require a waterfall at all, but merely rapids in a stream. The water is diverted by a ditch, flume or tunnel and conducted around the mountain side at a less grade than that of the stream. When this is continued for many miles it is evident that a difference in level will occur between the water in the ditch and that in the natural run of the stream. As a consequence at the end of two to fifteen miles of ditch, flume, or tunnel, we have a drop of from one hundred to even as high as twenty-five hundred feet. Such artificially created waterfalls are more typical of western development than the utilization of a natural fall.

Western Records

The mountainous situation of these developments, the tremendous heads which it has been possible to develop and the great distances involved in the transmission of power to the centers of population have demanded both originality and daring in the engineers who have been called upon to meet the problems, with the result that precedent has often been disregarded and history written along many lines of engineering achievement.

Among the records which typify the magnitude of western development may be mentioned the following:

Hydroelectric Generation

The largest single discharge turbine in the world: 20,000-hp.—Wise Power Plant, near Auburn, California; Pacific Gas & Electric Company.

The most powerful high-head turbine in the world: 23,800-hp.—White River Plant, near Seattle; Puget Sound Power & Light Company. A unit of practically similar size is installed in the Long Lake Plant, near Spokane, Washington; Washington Water Power Company.

Other large units: Southern California Edison Company is installing two 22,500-hp., 800-ft. head Francis reaction type turbines in its Kern River No. 3 plant, while the Great Western Power Company will install impulse wheels under 1008-ft. head at its Caribou plant on the Feather River with capacity of 30,000-hp.

The highest head plant in America: The San Joaquin Light & Power Corporation plans two units under 2500-ft. heads in connection with its King River project, already begun, and a similar head is contemplated by the Southern California Edison Company in the Big Creek development.

Typical also of western construction is the 17-ft. section tunnel being driven by the San Joaquin Light & Power Corporation to serve its Kerckhoff plant, a world's record in dimensions for hydroelectric tunnels, a steam shovel being used in mucking inside the tunnel.

Transmission

First long distance transmission: 20 miles at 10,000 volts from San Antonio to San Bernardino, California.

Longest high voltage transmission: 87,000 volts and 55,000 volts, 539 miles, from Mono County, California, to Yuma, Arizona; Southern Sierras Power Company.

Highest voltage transmission: Present record, 150,000 volts, 240 miles, Big Creek to Los Angeles; Southern California Edison Company. The Great Western Power Company is now installing a 165,000-volt line from its Caribou plant to San Francisco. The Pacific Gas & Electric Company has in contemplation the building of a 220,000-volt line from its Pit River plant into San Francisco, while other western companies are planning 220,000-volt lines for the near future.

Long span aerial crossing: Carquinez Straits; Pacific Gas & Electric Company. 6 steel lines, 4427-ft.—for a long time the longest in the world, now second longest.

Longest high voltage submarine cable: 3½ miles, 11,000 volts; Oakland to San Francisco; Great Western Power Company.

Dam Construction

Other records have been attained in the construction of dams in electric and related water development projects, a few of which may be mentioned here.

Highest dam in the world: Arrowrock, Idaho, 346½-ft.

Greatest storage of water in America—second in world: Elephant Butte, New Mexico, 2,638,868 acre-ft.

Second greatest storage of water: Roosevelt, Arizona, 1,367,300 acre-ft.

Highest rockfill dam: Morena, near San Diego, California, 267-ft.

Steam Generation

Steam is of course used throughout the western region for standby purposes and in some sections of the West it still proves the more economical source of power. Taking the district as a whole, however, hydroelectric generated power far exceeds steam generation, the proportions being about 75% hydroelectric to 25% steam. It is nevertheless of importance to point out the predominance of fuel oil as a fuel in the

NORTHWEST WATER POWER

One of the important hydroelectric developments of the Portland Railway, Light & Power Company. Washington and Oregon together have 16,600,000-hp. of the 59,360,000 potential horsepower of the entire United States. Less than 4% of the power possibilities of these two states have been developed to date.

southwest region and California, as well as to call attention to such economy records as that made by the Arizona Power Company, where a record of 333.3 kilowatt hours per barrel of oil is said to have been obtained. With the program of construction in the development of water power now under way, and planned for the coming ten years, however, steam generation will become a still more minor factor in the electric service of the west, except for standby purposes.

Power Consumption Data

The power consumed in various sections of the country makes interesting comparisons. It may be noted

TABLE NO. 3

District.	Population	Millions kw. hr.	Million dollars gross rev.	Kw. hr. per capita	Cost per kw. hr.	Revenue per capita
New England	9,448,000	2,398.6	64.47	254	$0.0293	$ 6.82
Atlantic	36,798,000	13,340.5	304.71	363	0.0228	8.24
Central	54,222,000	14,688.1	299.02	271	0.0204	5.52
Western	9,375,000	6,307.5	104.80	673	0.0166	11.17
TOTAL	109,843,000	36,734.7	773.00	334	0.0212	7.05

that the western states have the highest per capita consumption and the lowest rates of any, due to the available water power. The data in Table 3 is for the year 1919.

Comparing the uses of electricity in the west it is thus to be seen that the per capita use of electricity in the far western states is 2.21 times that of the remainder of the nation. Again it is interesting to note that while distances are vast, the development of long distance hydroelectric transmission has made possible electric power rates that are extremely low, averaging 1.66 cents per kw-hr., as compared to 2.19 cents per kw-hr. obtaining elsewhere in the country. In spite of these low rates the income to the power company per capita is almost twice that east of the Rockies.

Figures made public on April 8, 1920, by the Department of the Interior, gives some startling comparisons:

JANUARY, 1920, OUTPUTS

Nine western states	477,833,000-kw-hr. by water power
All other states	796,568,000-kw-hr. by water power
Nine western states	161,214,000-kw-hr. by fuels
All other states	2,418,984,000-kw-hr. by fuels
Nine western states	639,047,000-kw-hr. total
All other states	3,215,552,000-kw-hr. total

PER CAPITA CONSUMPTION

Nine western states	54.8-kw-hr. per capita from water power
All other states	8.12-kw-hr. per capita from water power
Nine western states	18.5-kw-hr. per capita from fuels
All other states	24.6-kw-hr. per capita from fuels
Nine western states	73.3-kw-hr. per capita total
All other states	32.72-kw-hr. per capita total

This table shows that the per capita consumption in the western states, of energy produced by water power, is 6.75 times that consumed in all the other states. The per capita consumption of power from both fuel and water power in the western states is 2.24 times that of the other states. This consumption of water power energy is particularly striking in that it is the result obtained in a dry year, as under normal rainfall the production of a large part of the energy now produced by fuel would have been supplanted by water power and given a still higher ratio between the per capita consumption in the West as against the East.

Distribution of Potential Water Power

Attention is directed again to Table 2, which shows the potential water powers of the western states in detail, together with the development water power data for these states which has already been discussed.

Of the total potential water power of the United States the State of Washington stands first with 9,500,000-hp., or 15 per cent of the total potential water horse-power of the United States. California is a close second with 9,250,000-hp., or 14.6 per cent of the total United States. Oregon ranks third with 7,000,000-hp. or 11 per cent of the total of the United States. These three Pacific Coast states together represent 40.6 per cent of the total potential maximum horsepower of the United States. Including the states of Idaho and Montana, **these five typically western states represent 57.1 per cent of the total potential maximum water horsepower of the United States with a total of 35,750,000-hp.** These figures all clearly emphasize that the problem of future water power development is quite distinctly a western problem, and this is stated without detracting in any way from the wonderful developments which have been accomplished in the East.

Developments Contemplated in Eastern States

In the eastern states some large developments are contemplated on navigable streams. Over 1,000,000-hp. is contemplated in the states of Alabama, North Carolina, Georgia, and Maryland. At some future time it is to be expected also that economic conditions will force the further development of Niagara Falls, of which approximately 75% remains still undeveloped. Increased efficiency of existing plants through interconnection of plants and development of storage facilities is to be expected in the near future.

The electrification of the trunk line railroads of the western section of the United States will require the development of a portion of the water powers of that territory. In the carrying out of this electrification, transmission lines will of necessity run along the railway lines and pass through the centers of population adjacent thereto. These lines should thus readily become the interconnecting links between local networks. The railway electrification, therefore, in addition to creating a new market for electric power will be an agent in the creation of a large network.

The future growth of water power developments can come only with growth of load of which more will be said later.

A 20,000-KW. PLANT ON THE UTAH SYSTEM

The Oneida Hydroelectric Plant of the Utah Power & Light Company, which is designed for an ultimate capacity of 40,000 kw. The industries of Utah are largely those of mining and agriculture, both of which are large consumers of electricity.

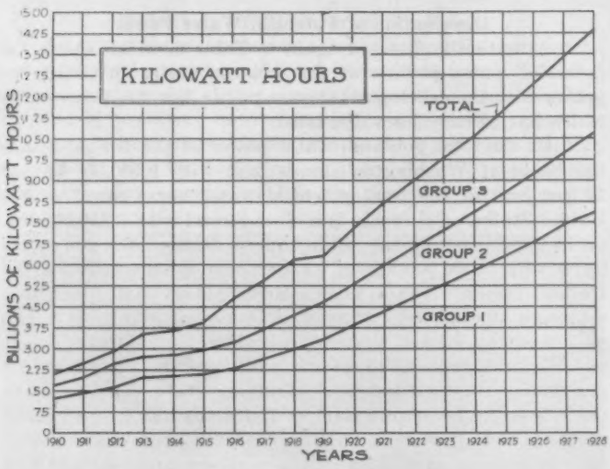


Fig. 1.—The steady growth of the output of the western companies is graphically indicated by the above curves which show the total annual output increasing from 2.05 billion kw-hr. in 1910 to 6.25 billion kw-hr. in 1919. Group 1, California district; Group 2, Northwestern district; Group 3, Mountain district.

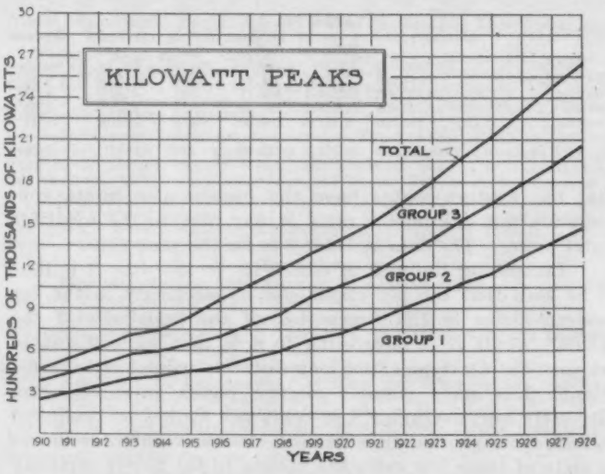


Fig. 2.—The curve of kw. peaks is the total of the several companies and does not represent the peaks which would occur if the companies were completely interconnected. Group 1, California district; Group 2, Northwestern district; Group 3, Mountain district.

Future Growth to be Anticipated in Power Development

In order to get accurate data on power possibilities, or rather power to be anticipated during the next decade, a questionnaire was sent out to all the fifty-two power companies in the far western states calling for a statement of their load during the past ten years, and also their estimated load up to, and including, 1928. Superimposing these various load charts, one upon the other, we arrived at the interesting conclusion that during the next ten years the expected development of power in the West will rise to the vast total of 1,776,260-kw. At present-day prices the investment capacity at power plants is running in the neighborhood of $200 per kw. The transmission, transformation and distribution expense and incidentals involved in properly marketing the product, will entail an additional expenditure of some $200 per kw.

Thus it is readily seen that something like $710,510,000 must be expended in the West before 1929 to meet the situation. While this vast amount of capital is necessary as a prime source of development, it is easily seen that such development will carry along with it an equal call for electrical installation in appliances in the home, upon the farm, and in industry, that may well total an equivalent amount. We are principally concerned, however, with the question of the first three-quarter billion, for with that secured the remainder finances itself. Indeed, so important, not only to the continued prosperity of the power companies involved, but to the nation itself, both East and West, is the problem of water power development, that it is not overemphasizing the matter to state that the most vital question before this convention is the securing of that $710,510,000, as well as the millions needed for developments east of the Rockies—in short, the question of financing.

The Self-Interest Appeal

Recent interest in the West has been focused on what has become known as the "self-interest" appeal. From a well known power company the following data has been supplied as taken from the records required by the regulatory body of the state wherein the power company operates, in which capital in former years for power development was distributed as shown in Fig. 9.

Examining the details of this chart we may with reason predict to what extent various subdivisions of industry will be interested in the investment of this $710,510,000. Thus the transformer man knows that 7½% or $53,000,000 of this money will go to his business; and so on down in other branches of the industry, the copper man, the fabric man, and indeed all the allied and side industries that go to make up or furnish supplies for the manufacture of electrical apparatus involved. To the man in the street too, the problem is of unique interest and may be made to appeal to him personally. One instance will suffice: In the district surrounding Fresno, California, two thousand applicants for power for farm development cannot at the present time be connected upon the power lines due to insufficient power installation. In former years it has been found that in that district for every farm delayed in development in the country two homes in the city are delayed in construction. Investigation shows that the average home in and about that vicinity has a value of some $5000. Thus it is seen that $10,000,000 in construction is delayed at the present time in that one community due to the inability of the power companies to furnish this power. The tabulation in Fig. 10, taken from builders' records, represents the various channels wherein money for construction and building purposes in the city is disbursed in that particular section.

Water Power Development Essential to Western Growth

Even a casual survey of this chart brings to light the fact that the plasterer, the overall man, and indeed every form of labor and industry is vitally affected when stagnation in the power industry occurs. While conditions in other sections of the country may vary in detail from this, it is everywhere demonstrable that local stagnation follows a failure of electric generation to keep pace with the building of the empire it serves. With the tremendous growth of the West—in California alone applications for water to irrigate an additional acreage equal to 50% of the total already under cultivation have been filed in the last six months—combined with the high price and diminishing supply of fuel, it is obvious that for this region it means that the development of the country is dependent on hydroelectric development—dependent, in other words, on the financing of the three-quarter billion construction planned.

Western Power Application, Present and Prospective

A like evidence of the dependence of western growth upon electricity and also of the certainty of a tremendously growing demand in the future is the survey of western industries.

In the intermountain region where mining and agriculture share the prosperity of the country, both are largely dependent upon electricity. Such examples as the vast electric pumping irrigation project at Minidoka, Idaho, and the electrified mines of Montana, Idaho and Utah, largely account for the high per capita use of this district.

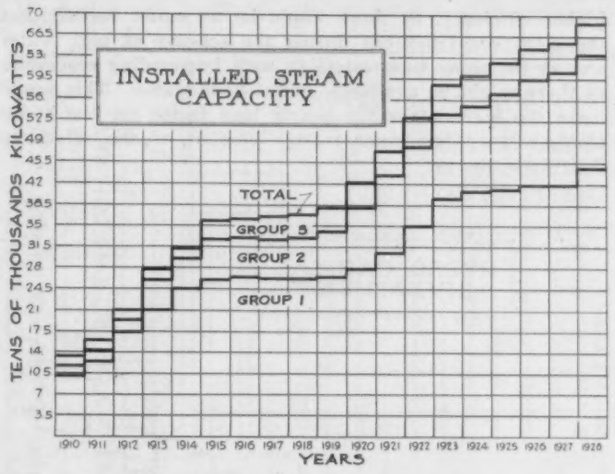


Fig. 3.—The flattening out of the installed steam capacity curves indicates that the hydro capacity is expected to more nearly meet the load demands, steam capacity still being sufficient to give service.
Group 1, California district; Group 2, Northwestern district; Group 3, Mountain district.

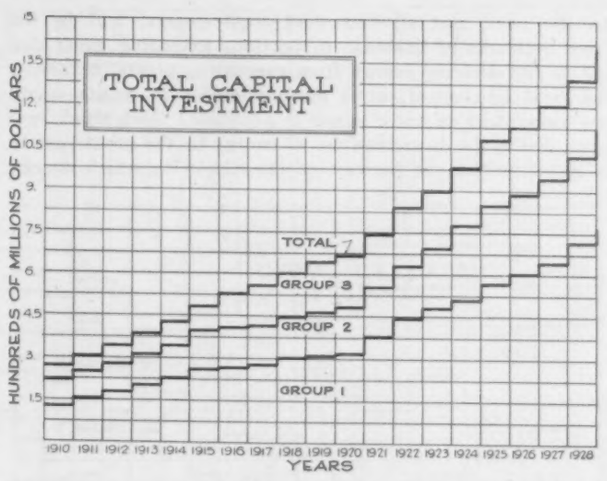


Fig. 4.—The curves of capital investment are based on an estimated investment of $400.00 per kw. for the total system. At the end of 1928, this investment will reach $14,250,000,000.00.
Group 1, California district; Group 2, Northwestern district; Group 3, Mountain district.

In the Northwest, paper mills find the electric drive indispensable, and in the lumber industry also first experiments in electric logging have shown electricity to be more economical than previous methods, and the electrification of sawmills is becoming quite general.

Electro-Chemical Possibilities

Large quantities of copper, lead and zinc are mined and smelted in the western states. These are shipped to eastern refineries. Due to the increasing cost of power in the East and the fact that these refineries must compete with industries in which the cost of power is a smaller item of the total cost of production, we may expect an enlargement of the existing refineries and the installation of additional refineries in the West in the near future. The electrolytic zinc plant now located at Great Falls is the largest in the world and has a daily capacity of 150 tons of the highest grade of zinc.

We may also expect an increased consumption of electric power in electric furnaces for the production of alloy and steel which already forms a considerable load. There is a possible future use for electricity in the development of the chemical resources of the West. Advancements in technology have made possible the use of reagents in these industries that can be produced by electric energy. These developments will, of course, require co-ordination of certain chemical industries and close co-operation with the power companies.

Present and Future Agricultural Load

The primary basis for western prosperity, however, undoubtedly lies in its agricultural development and here electricity has played a most important part. Due to the general arid climate with an absence of summer rains which prevails throughout the greater portion of the region, particularly the Southwest, irrigation is an essential to the cultivation of the soil. Gravity irrigation is, of course, used to the fullest extent, but it is inadequate to supply the need and is being supplemented in steadily increasing degree by electric pumping. To this consideration may be attributed the fact that California uses more electric power on the farm than all the rest of the United States put together, the remaining western states ranking second.

An example of the importance of electricity to this development is to be seen in the rice industry, now one of the important crops of California, which depends almost entirely on electric pumping for its existence. This industry was not started until 1912, but a $27,000,000 crop was shipped from the state in 1919 and the only bar to a 25% greater acreage in 1920 is the shortage of electric power, a striking example of the dependence of agricultural growth upon hydro-electric development.

There are in addition, various important but nevertheless minor industries in the region, listed in the census reports as 7% of the manufacturing activity of the United States, all of which are to a great extent users of electricity. It should be pointed out, however, in favor of the stability of western power demands, as well as the importance of electrical development to western growth, that the major industries already mentioned are essentially dependent upon electricity, whereas in the average manufacturing interest, it is a factor of smaller relative importance. Thus the abundance and cost of electric energy is the determining factor as to whether such enterprises as additional irrigation, electro-chemical propositions, or activities involving the use of the electric furnace shall or shall not be undertaken.

Pooling of Power Resources

During the war it was found necessary, in order to increase production, to pool the resources of the nation. Power for operating our industries was demanded as never before and on very short notice. One of the expedients resorted to in keeping abreast of these unprecedented demands was the pooling of power resources through physical interconnection of adjacent systems.

New experiences were encountered and many economies were effected. Those who came in contact with the larger aspects of these war problems and participated in working out their solutions learned that the methods developed and applied under the stress of war were in fact destined to become of even greater importance under conditions of peace.

There is, therefore, as a result a well-defined movement at the present time looking to the unification of the power systems of certain sections of the country, a movement which, once it gets under way, will gradually spread over the entire country.

We have passed successively through the periods of the isolated plant, the individual central station plant, with its more or less limited distribution lines, and are now in the period of the central station system of a number of generating plants, hydro and steam, connected to the transmission network of the utility. The next period is to be that of the unification of the power resources of large subdivisions of the country.

In this unification plan the entire power requirements of the district, comprising at first possibly a single state, later several states and eventually the entire country will be treated as a co-ordinated whole. The power and light, and possibly the heat for the factory, the mine, the locomotive

on the rails, and all household requirements, will be fed from networks of immense proportions extending great distances and deriving energy from generating plants containing the most economical prime movers located at points where low priced fuel or water power is available. Such trunk systems, due to the diversified use of energy by the great variety of users served, and because of the ease with which energy

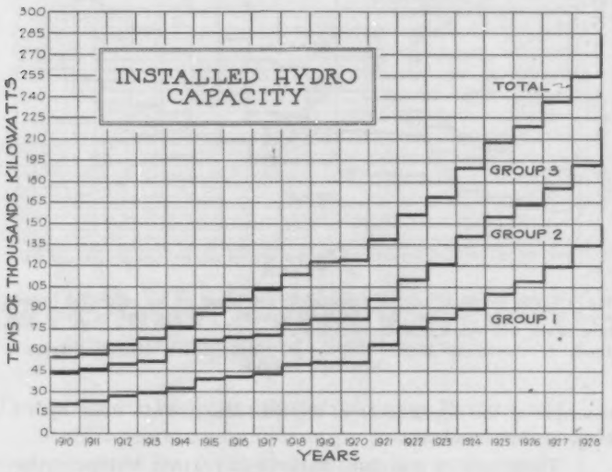


Fig. 5.—After the post-war period of 1919-1920 the rate of increase of hydro capacity shows a steady growth.
Group 1, California district; Group 2, Northwestern district; Group 3, Mountain district.

from flood waters on one system might be absorbed, thereby making possible the impounding of the maximum amount of water on another system, and because of the ability to absorb energy produced by regeneration of electric locomotives on descending grades, will operate at a very high load factor and the cost of producing energy will be at a minimum figure.

Advantages of Local Diversity

The diversity in use between individual networks, many of which would be fed from the trunk system, would be of immense advantage in keeping down to a minimum the capacity and investment in generating plants required.

Seasonal variations in climatic conditions would be taken advantage of through the interconnecting network and would result in a steady supply of power in certain sections, on the watersheds of which for the time being there might be serious water shortage.

Such trunk systems would fit in admirably with hydroelectric development and the utilization of large units of

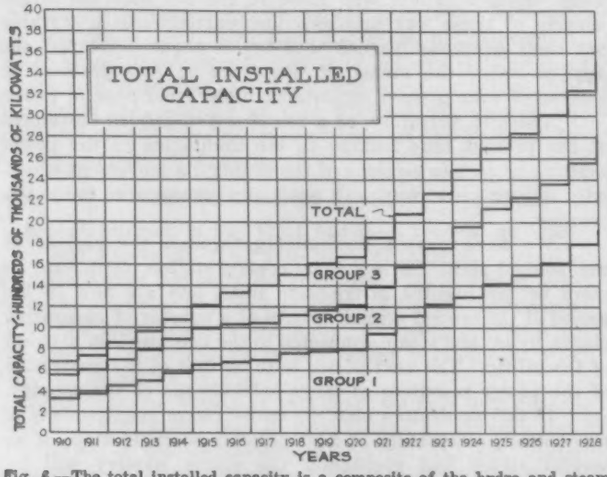


Fig. 6.—The total installed capacity is a composite of the hydro and steam capacities and shows almost a straight line growth for the next decade.
Group 1, California district; Group 2, Northwestern district; Group 3, Mountain district.

higher efficiency, as there would be an outlet for all that the plant could put out during the seasons of high water and at the same time catch, in such impounding reservoirs as there might be available, excess flood water. This would mean the highest possible yearly load factor for the hydro plant—a very important matter because of the relatively high fixed charge.

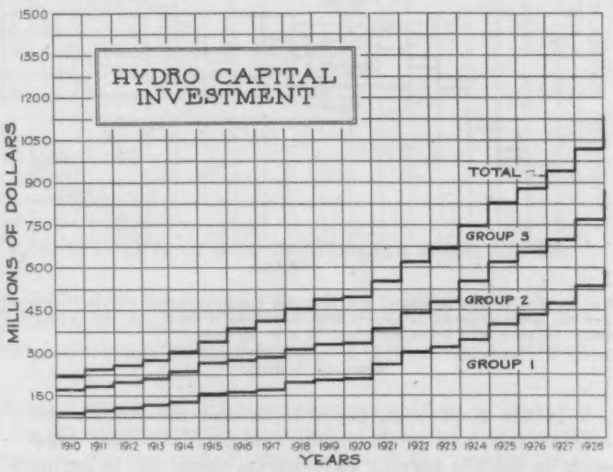


Fig. 7.—The above curves of hydro capital are based on an investment of $400.00 per kw. of capacity which covers plants, lines and substations for placing this power at the disposal of the consumers.
Group 1, California district; Group 2, Northwestern district; Group 3, Mountain district.

Conservation of Fuel Oil

Another phase of such an interconnected system is the possibility of fuel-oil saving, which in the Pacific Coast states is rapidly becoming an imperative necessity.

The fuel oil situation in the western states has been recently set forth quite clearly by Mr. K. R. Kingsbury, president of the Standard Oil Company of California, in an open letter to the California Railroad Commission explaining the causes leading up to the recent increase in prices of fuel oil and gasoline.

The following extracts from this statement are representative of the situation:

"The Pacific Coast supply of fuel oil and of petroleum products is rapidly approaching exhaustion. Since May 1, 1915, crude oil stocks in California have decreased from over 60,000,000-bbl. to 28,738,921-bbl. on March 1, 1920.

"The available supply of crude oil in stock is today less than 13,000,000-bbl.

"The balance of the stocks are taken up in the factor of safety of 10,000,000-bbl., which the Petroleum Committee of the State Council of Defense found essential to the safety of Pacific Coast industries, and in the oil in pipe lines and tank bottoms which the same committee estimated at 6,000,000-bbl. not available for use.

"At the present rate of consumption and of production the available stock will be exhausted in about 12 months, at which time consumers of California fuel oil will be cut off from between 25,000 to 30,000-bbl. per day.

"The condition is not a temporary one but the culmination of a steady growth."

A great deal of additional information on the subject is given in Mr. Kingsbury's statement.

The point that we are chiefly concerned with in this connection, however, is the possibility for hydroelectric systems to assist in the conservation of fuel oil supply.

The two largest central station companies in the State of California have found it necessary, in spite of their large hydroelectric developments, to consume oil at a rapidly increasing rate, as shown by the following totals for the two companies:

	Barrels of oil consumed
1916	1,047,886
1917	1,596,149
1918	2,073,016
1919	3,088,145

While this consumption of these two central station companies represents only a small portion of the total consumption for all purposes in the local market it does reflect the trend in the increase of fuel oil consumption.

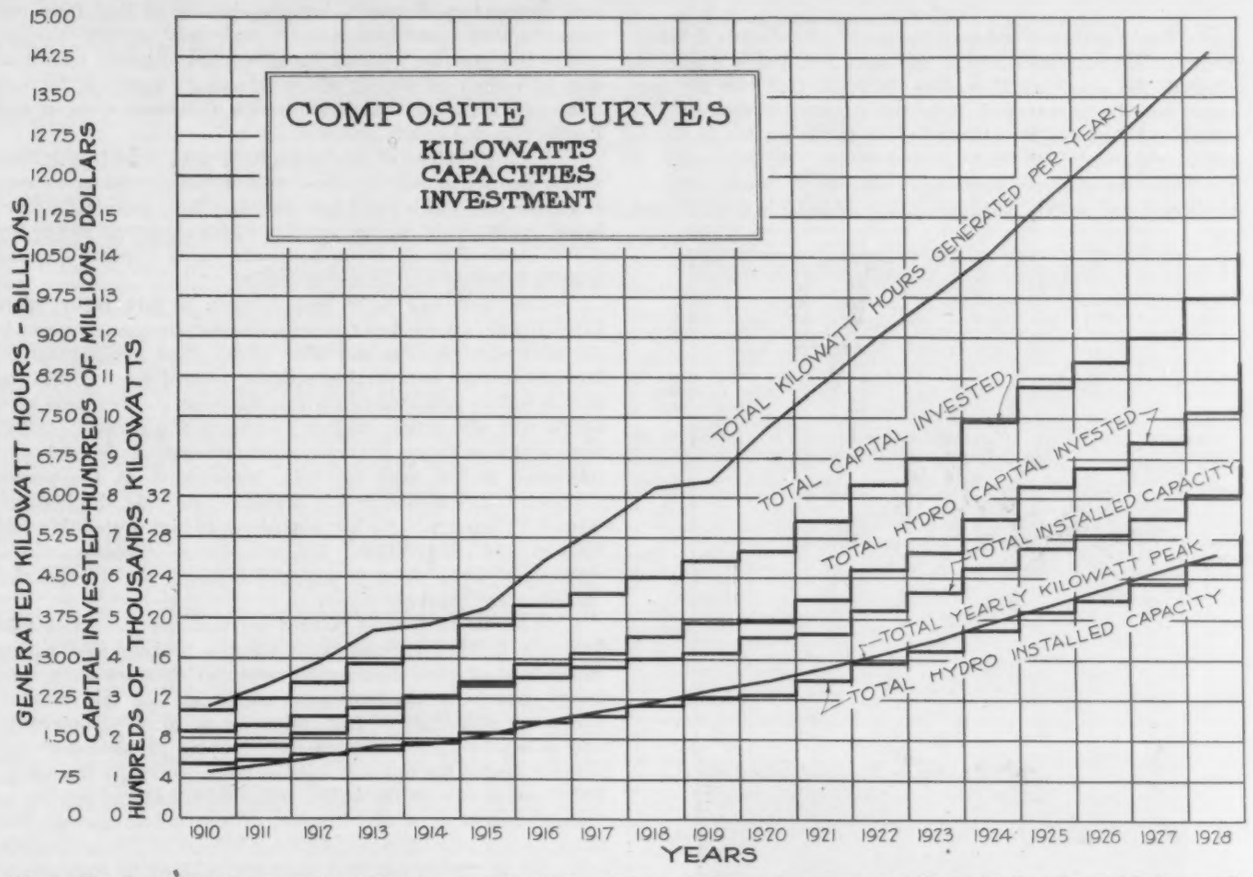


Fig. 8.—The above figure is a composite of Figs. 1 to 7. It should be noted that the kw. peaks are only slightly greater than the total hydro capacity installed indicating that little fuel will be burned. The curve of total hydro capital is based on an investment in power plants, transmission lines and distribution systems of $400.00 per kw. installed hydro capacity. The curve of total capital is based on a total of $400.00 per kw. of both hydro and steam capacity.

Auxiliary Benefits

Further development of hydroelectric power will mean not only an important direct saving in fuel consumed by the central stations, but also a much larger saving in fuel consumed by other large power users in California, who would utilize electric power if it were available. The power shortage makes this impossible under present conditions.

The power shortage at present existing in California does not prevail in the other states of the West, but the demand for power in the other western states is rapidly approaching the maximum capacity of the central stations therein, and if further development is not vigorously pushed the power shortage conditions of California will be duplicated in practically every western state.

It is furthermore becoming of importance that the remaining supply of crude oil be conserved in so far as possible for its more valuable products of gasoline, mineral oils, asphaltum, etc., and for such uses as marine fuel and other power purposes where electric power from hydro plants is not available. This represents the highest type of conservation and its ultimate development lies in the maximum utilization of hydroelectric power and the transmission and distribution of this power through a comprehensive interconnected system providing for the highest and most efficient use of the generating plants.

California Trunk System

At this point it is of interest to note that much has already been accomplished in California in making a start toward the establishment of a trunk system. During the year 1918-1919 there were two sets of interconnected networks in the state, one in the northern, the other in the southern portion. The control of each system was under the management of a power supervisor. As a result of this arrangement there was effected a saving of 300,000-bbl. in 1919, representing $450,000. In the later part of 1919 a connection of the northern system with the California-Oregon Power Company extended that network into the state of Oregon. Within recent weeks a connection between the lines of the Pacific Gas & Electric Company and those of the San Joaquin Company has tied the two networks into one and there is now a continuous trunk extending from the southern part of Oregon to the Mexican border. This is the most extensive network in the country today.

Northwest Interconnections

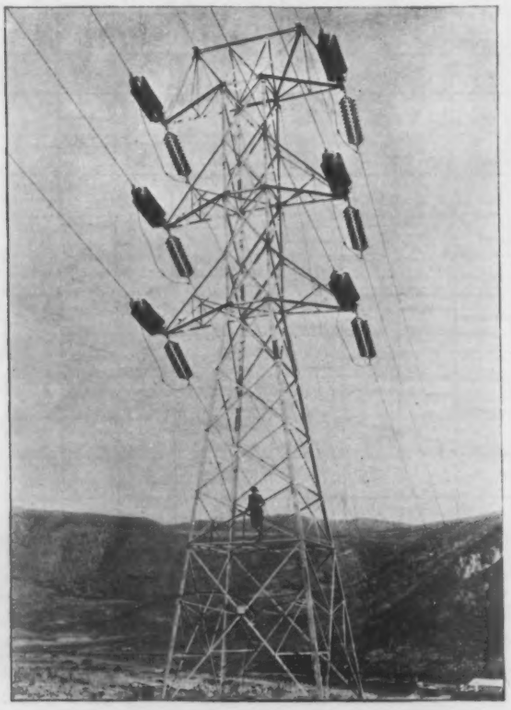
When the final gap between the Washington Water Power Company and the Montana Power Company is closed, either by one of these companies, or by the Milwaukee, almost the entire Northwest will be interconnected.

While it does not fall within the scope of this report to deal with this subject in detail, it is nevertheless proper at this point to call attention also to the recent paper by W. S. Murray and others in the March Journal of the Institute of Electrical Engineers on the economic supply of electric power for the industries and the railroads of the northeast Atlantic seaboard. This article deals with a so-called super-power zone and sets forth the results of some interesting economic studies of the power supply contemplated for this important section of the United States.

By treating all the power requirements of the territory as a whole and serving everything with one large trunk system there are enormous economic advantages to accrue both directly and indirectly.

Conclusion

The importance and magnitude of hydroelectric development as contemplated within the next few years should be clear to the most casual reader. In order that this development may be encouraged, it is the recommendation of this committee that due attention be given to the matter of favorable legislation, both Federal and State. In California, in particular, unsatisfactory state laws hinder the ready development of water powers which are assumed to be in conflict with



THE TRANSMISSION OF HYDROELECTRIC ENERGY

Grace terminal of 130-kv. transmission line, showing the heavy anchor tower and quadruple strain as used for long spans. The problem of high tension transmission is closely bound up with hydroelectric development in the west, where long distances must be traversed between the power developments in the mountains and the population centers.

other riparian rights on the stream. It should be the endeavor of this body and its members as individuals to remedy this and other unfavorable conditions which discourage investment. Important legislation is now before Congress, covering both the development of water power upon navigable streams and the broader question of water rights on government land. As urged elsewhere in this report, it seems advisable that a permanent committee be established by the National Electric Light Association to represent the interests of the electrical industry as a whole in the formulation of rules and regulations which shall govern the application of these measures.

It is further advocated that the policy of trunk line transmission, at 220,000 volts and over, be advanced as an economic possibility. We believe that all future activity in hydroelectric development the nation over should look toward unification and in a measure toward standardization of high voltage busbar installation. As particular instances, the early future should see giant power lines of 220,000 volts and upwards extending north and south through California and thence on upward to the Columbia and into the industrial center about Seattle, thence over the Cascades into Spokane, and Butte, Montana. It seems apparent that such systems will not only make feasible the most economic development, but will also do much to equalize the variations in rainfall to be expected from season to season, through the possibility of transferring power from one section where water is plentiful to another where a shortage obtains. This does not necessarily mean the actual transference of large blocks of power over tremendous distances, but the shifting of load from one power system over into another and then on into another makes this possible without the actual long distance transmission of energy—a benefit which is already apparent in such interconnections as that between the California-Oregon and Pacific Gas & Electric systems.

Such a system of interconnection with superpower lines would also make possible the development of smaller powers along the line which could not otherwise be economically marketed and it would lay the foundation for supply of power for the electrification of steam railroads which popular demand is daily bringing nearer consummation.

The fact has been brought out in this report that $710,510,000 is needed to finance hydroelectric construction for the next nine years in the West alone. The public must be brought to such a favorable attitude toward electric utilities that it will be prepared to furnish this money. How this may be brought about is a subject worthy of the earnest consideration of this body. It is obvious that the public is as closely concerned in the need for this development as the power companies themselves, and it seems logical that the benefits to each citizen need only be pointed out to him to gain his full interest and cooperation. The wide-spread education of the community should then be undertaken along the lines of the "self-interest" appeal.

It should further be pointed out that the success of this financing is likewise contingent upon a broadminded policy on the part of regulating commissions which must allow sufficient returns to the power companies so that the investor may see a possibility of fair return on his money. Indeed, it may safely be said that upon the adequate protection of the investor hinges the entire matter of power company financing. The function of a public utility commission has two aspects—the safeguarding of the interest of the public and at the same time a consideration of the welfare of the companies regulated to the extent that they are enabled to maintain a state of health and adequate growth. We cannot urge too forcefully the broadest spirit of co-operation between such regulating bodies, the electrical industry and the public, in order that the needs of the commonwealth may best be served.

Fig. 9—Segregated investment of capital for electric power development.

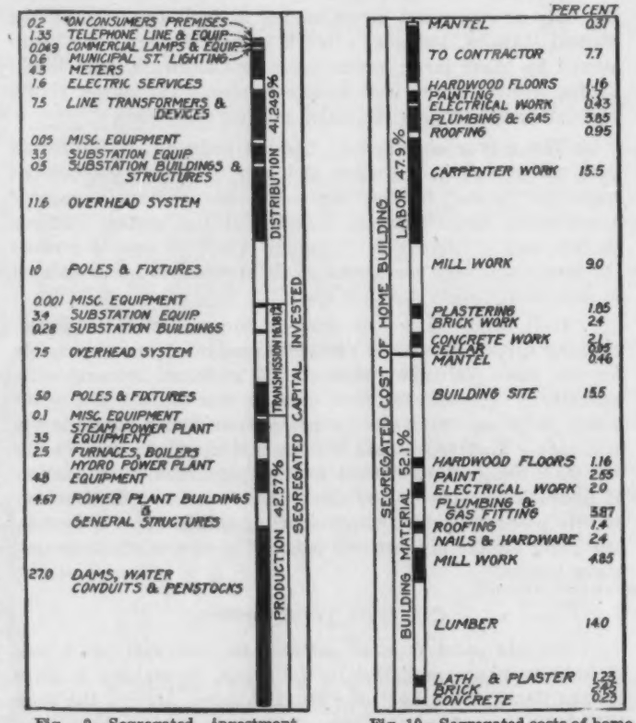


Fig. 10—Segregated costs of home building compiled from builders' records.

APPENDIX "A"

QUESTION: "What, if any, influences are retarding the development of water powers in your state?"

Answers

Washington. (#47 D). Referring to the portion of the state east of the Cascade Range, I should say that in general the reason why development has not proceeded to a greater extent than it has is because of the lack of market.

(#56 D). As far as the Pacific Northwest is concerned, I believe competition from municipalities and the present laws governing the development of water power and the acquisition of riparian rights for such developments within the forest reserve are the principal factors having influence towards retarding development of water powers.

Oregon. Lack of suitable Federal legislation permitting the development of water power on Federal reserves. Lack of public appreciation of the necessity of adequate revenues from operation to make investment attractive.

California (#40 D). The influences retarding the development of water power in the State of California are the influences that have retarded the development of water power in all public land states—briefly stated, the inertia of Congress, interference by hysterical conservationists, a lack of human intelligence and a lack of recognition not only of the rights of these public land states but the necessities of the people therein for production of power to encourage industries.

(#44 D). The established doctrine of riparian rights has had a great deal to do with retarding water power development in California. It has been for years recognized as a great misfortune that the law of riparian rights ever obtained a foothold in California, since it is wholly incompatible with the doctrine of prior appropriation which is applied in the public lands of the United States. No rights secured by appropriation can be enjoyed at the expense of the full measure or riparian rights vested in the owners of lands riparian to the lower reaches of the stream. It has been necessary for power companies in California to obtain consent to agreements with riparian owners in order to make development under the appropriation laws of the state and of the United States. While the use of water for power does not take it away from the riparian owner, it does, especially where there is storage, bring it to the riparian owner in different quantities and at other times than it would come in the course of nature, and he is entitled as a riparian owner to have the water flow exactly as it would in a state of nature, subject to reasonable use for domestic supply and for irrigation of riparian lands by other owners along the stream.

Colorado (#21 D). The development of water power in the state has been retarded by the refusal of capitalists to invest their money in developments which would be compelled to operate under the unattractive terms of a government permit.

(#41 D). Water power development in Colorado has been very much retarded and some large projects have been entirely blocked by the attitude of the general government. Most of the water power sites are on government land. Refusal of the Forestry Service to grant rights of way over public domain and refusal to issue anything but temporary indefinite permits, etc. Best water power sites are on public lands.

Montana (#14 D). The fact that the government of the United States has made large withdrawals of power sites along available rivers is a retarding influence and some law of Congress should be passed providing for the opening up of these undeveloped water power sites and the making of them available for use in operating both the Northern Pacific and the Great Northern railroads in the mountain regions.

Nevada (#53 D). No present demand for further development.

Utah (#52 D). Failure by Congress to enact a water power bill is seriously retarding the development of water powers. Practically all of the undeveloped sites are upon the public domain withdrawn from entry, either as national forests, or as water power sites.

Arkansas (#31 D). Lack of demand for power is probably retarding the development more than anything else.

Connecticut (#28 D). The greatest influence retarding water power development in New England is the lack of co-operation among the various states. Most of our streams are interstate streams and the greatest requirements of our water power is increased storage in the headwaters, but because of the lack of co-operation between the various states the benefits of storage reservoirs created in one state and favorably affecting water powers in another state cannot be assessed upon those lower water powers because they are in a separate state from that in which the storage reservoir is located.

District of Columbia (#16 D). In our opinion it has not seemed feasible to develop any possible water powers in this vicinity due to the lack of continuous supply of water.

Georgia (#32 D). The influences retarding the development of water powers in this state are first, the difficulty and the cost of obtaining money for these purposes; second, the regulation of rates for power service supplied by the public utility company and the disposition to hold down utility rates to such a point as not to yield sufficient return on the capital required to induce investment of capital in the enterprises.

Illinois (#57 D). There are comparatively few water power sites of importance in Illinois. So far as these are located upon wholly non-navigable streams the state has no jurisdiction over them, and the private owners on either side of such a stream may make such use of the stream for water power purposes as they desire, subject, of course, to the riparian rights of owners above and below them. In this state title to the bed of a stream, whether it be navigable or non-navigable, is in adjoining owners, and not in the state. In the case of navigable streams the state has the right to prevent obstruction to navigation, and to control erections in the stream until such time as the Federal government takes control of such stream as a part of the navigable waters of the United States. The state authorities have made some efforts to declare by legislative act certain streams to be navigable which had previously not been so considered. One notable case of this sort has been in connection with an act passed in 1907 declaring the Desplaines and Illinois Rivers to be navigable. At that time the Economy Light and Power Company was engaged in constructing a dam for water power purposes across the Desplaines River at Dresden Heights below Lockport. The state instituted a litigation against the company, based upon this act, involving the **de facto** navigability of the stream. Later the Federal Government instituted a somewhat similar action. As a result of this litigation, work upon the dam was stopped and has not been resumed.

Indiana (#17 D). Nothing but economic conditions are retarding development of water power in this state. High cost of hydro development, cheap Indiana coal and lack of uniformity of flow of Indiana streams prevent economically the development of hydro possibilities.

Iowa (#3 D). None. Entirely an economic matter.

(#25 D). None, except high cost of land overflowed.

Kansas (#51 D). The smallness and uncertainty of the discharge and the cheapness of steam power are contributing factors in the discouragement of water power development in this state. The river (Verdigris River) is close to the coal mines and the center of a natural gas belt. It is believed that the influences which affect water power development on the Verdigris River in Kansas are representative of the state as a whole.

Kentucky (#23 D). Markets and money. Laws seem to be O. K.

Maine. See under Connecticut for New England states.

Maryland (#22 D). No influences except the high cost of development and the necessity of awaiting growth of the market have retarded development of additional power on the Susquehanna River.

Massachusetts. See answer under Connecticut for New England states.

Minnesota (#19 D). The majority of the rivers of this state available for water power development would be considered navigable streams and therefore would come under Federal control and until legislation is passed at Washington, no water power development of any consequence can take place in this state.

Missouri. No development of consequence to be expected.

Nebraska (#15 D). The retarding of the water power development in Nebraska is due to the shallow long streams and low heads being undesirable for development. There is much trouble caused by heavy snows and ice conditions at certain temperatures in the winter months which makes water power operation absolutely impossible.

New Hampshire. See answer under Connecticut for New England states.

New York (#24 D). The ratio between the developed and undeveloped power in this state is particularly low in view of the great industrial development throughout the state, within easy transmitting distance of very attractive power sites. The reason for this is partly because a considerable portion of the undeveloped power is on the Niagara and St. Lawrence River, ownership of which is disputed by the state and Federal Governments, and development of which is at present limited by international treaty.

The development of power on streams which are neither interstate nor internationl boundaries has been hindered by the lack of suitable legislation to make such development possible. There are two factions in the New York State Legislature, one of which is committed to out and out state ownership of all water power in the state, the other favoring private ownership with state regulation. Although bills have been introduced in the Legislature at nearly every session during the last twenty years neither party has had sufficient majority over the other to succeed in enacting any constructive legislation which would definitely start development on either basis. What development there is has been effected entirely on private initiative by the process of buying riparian rights, one at a time, and at the seller's price.

(#45 D). (A) The larger portion of the undeveloped power from streams within the state is in, or connected with, the State Forest Reserves, which cannot be entered for practical purposes, either by state or by private interests without a change in the constitution of the state.

(B) Generally speaking, the economical development of the rest of the power possibilities on streams within the state cannot be carried out without regulation of flow by reservoirs, to acquire lands for which will require the right of condemnation. It is held by many that such right cannot be given for water power purposes under the present state constitution.

(C) The bulk of the undeveloped power, about 2,000,000-hp. is on the international boundary streams, namely the Niagara and St. Lawrence Rivers, control over which is assumed by the Federal Government. Development of Niagara power is restricted by an international treaty limiting the diversion of water from the Niagara River to 20,000 cu. ft. per second, all of which is now utilized. The development of both the Niagara and the St. Lawrence Rivers is retarded by international questions and by the lack of definite water power policy on the part of the state and national governments.

Ohio. Very little water power development to be expected.

Pennsylvania (#39 D). Influences retarding hydro development in this state are cheap fuel, the extremely wide range of runoff, generally low available heads of streams located in the main in a broken country where large amounts of impoundage are difficult to arrange.

Vermont. See answer under Connecticut for New England states.

Wisconsin (#43 D). We do not feel that there are any influences retarding the development of water power in this state.

QUESTION: "What, if any, legislation should be enacted to make available for development the water powers of your state?"

Answers

Washington (#47 E). The only important legislation so far as I know which is lacking at the present time would probably be covered by the passage of the so-called Water Power Bill now pending before Congress.

Oregon. Passage of the water power bill now pending before Congress or similar measure is needed for future power development in this state.

California (#40 E). My personal view is that the legislation that should be enacted to make available for development water powers in this state would be legislation that would turn over free of any restrictions or taxation the land belonging to the government necessary for any water power development and leave it to the best qualified agency to develop. And this is, of course, an impossible thing to do under present circumstances, we should accept the best legislation we can obtain from Congress that will make it the easiest to secure capital for these developments.

(#42 E). It is our belief that certain legislation should be passed offering a larger measure of protection to the investors in public utilities and principally it should be beyond the power of any regulatory body to so limit the earnings of utilities that it cannot finance for the future needs of its territory. We have ourselves suffered acutely from a revision of rates which permitted us to earn a reasonable return only under the most favorable conditions of rainfall, material and labor costs, and money supply, and when a combination of two dry years, ascending prices and high interest rates struck us in conjunction, it rendered us entirely helpless, and we are only now seeing a change of opinion on the part of the regulatory commission of this state which has been largely brought about by an appalling condition for which they must be in a great measure held responsible. The policy of basing rates upon a combination of most favorable conditions, ignoring the well known hazards under which such utilities operate, will always produce periods running from embarrassment to disaster in which not only utilities suffer but their consumers and their territory likewise.

It is our view that the investing public would also be reassured if the rate fixing body were relieved of its function of "representing the people"; there is a serious inconsistency when judge and prosecutor are merged in the same identity and the state of California might well follow in the lead of certain of the great eastern states and separate these two functions of rate control. The regulatory and rate making body should be strictly judicial in its character and the tenure of office of its members should be so lengthened that they would not be quickly responsive to such manifestations of popular will as sometimes cry out for a virtual confiscation of business.

It should be said in closing, however, that the California Railroad Commission has lately shown a very hearty appreciation of the needs of the utilities and while the lesson has been expensively bought both by the companies and the public, it will likely be remembered for some time, and we are glad to say that at this time we are having co-operation and support to a very high degree, in fact, it seems as though the public, or certainly the more thoughtful portion thereof, have gotten different viewpoints lately and realize how largely their own interests are identical

with such utilities as ourselves, and such criticisms as may be inferred from our remarks are, as far as California is concerned, largely directed to a past condition.

(# 44 E). The doctrine of riparian rights is protected by the constitution and cannot be abolished by the Legislature. Eventually foot-hill reservoirs must be provided on all the large power streams which will receive waters after use for power purposes, and which will serve to regulate the flow of the stream so as to approach its natural flow, if insisted upon by riparian owners or so as to best serve the interests of irrigators. These regulating reservoirs are necessary to adjust the friction which now exists between the power interests and the irrigation interests of California.

The municipal ownership provision of the Water Commission Act which has already been referred to, is perhaps a deterring influence. A title to water power based upon the Act, subject to municipal appropriation at the end of twenty years is not a very satisfactory one to use as security to obtain the necessary financing. It would be desirable to have the period made the same as that contained in the present regulations of the Forest Department of the United States, and in the new Water Power Bill now before Congress.

Colorado (#21 E). Our government must be prepared to grant permits under terms satisfactory to capitalists and above all irrevocable.

(#41 E). I have no suggestions to make relative to legislation for encouragement of water power development, except for the government to remove or at least very materially modify their restrictions. These rstrictions, as I understand it, were made in response to the general demand over the nation for the conservation of their natural resources and for the restriction of monopoly. I do not fear any great monopolization of the water powers of our state for the reason that the most of it is in the mountain region and is divided into small units. Cities and towns, mining companies, and even small farming communities can readily develop individual units for their own private use. Then we have a Public Utilities Commission which can regulate prices where electricity is sold to the public.

Montana (#14 E). An Act of Congress providing for the opening up of numerous undeveloped water power sites under Federal control would aid to a large extent in making available the water powers upon the Clark's Fork of the Columbia River in Missoula and Flathead Counties.

Nevada (#53 E). None.

Utah (52 E). When the water power bill has become a law we are of the opinion that no other legislation will be required.

Arkansas (#31 E). The laws of the state should be amended repealing that portion which requires companies to pay to the state a percentage of gross revenues.

Connecticut (#28 E). Legislation should be passed in certain of the New England states providing for the co-operation between states and the establishment of storage reservoirs on interstate streams. There is very little, if any, co-operation between the states at present and these streams cannot be developed to their full possibility until such time as such co-operation is established between these states.

District of Columbia (#16 E). We do not think any legislation should be enacted looking toward the expenditure of large sums of money to develop any of the water power possibilities within this vicinity.

Georgia (#32 E). The legislation needed in this state is to authorize companies to change their rates whenever their conditions justify, either upward or downward and the rates to go into effect subject to review by the State Railroad Commission on complaint. Then a disposition upon the part of the public and the authorities to permit rates sufficient to attract the necessary capital into the enterprise.

Illinois (#57 E). We do not believe that any additional legislation is necessary to make the limited number of water power sites under public control available for development.

Indiana (#17 E). Financial state aid for the construction of the dam, head-race and tail-race The other parts of the hydro development could be sustained by private enterprises, but the cost of overflow privileges, the cost of the dam and the cost of the canal for private money is too much to permit of private development.

Iowa (#3 E). None.

(#25 E). Cannot answer.

Kansas (#51 E). Before legislation is to make available the greater use of water power in Kansas it will be necessary for the state to investigate water power more carefully and make a complete inventory of the present water power development. The Legislature of 1917 passed a Water Commission Act, which is the foundation upon which such an investigation may be made.

Kentucky (#23 E). I know of no legislation that should be enacted to make available for development the water powers of Kentucky.

Maine. See answer under Connecticut for New England states.

Maryland (#22 E). No legislation required.

Massachusetts. See answer under Connecticut for New England states.

Minnesota (#19 E). The enactment of proper legislation at Washington will do much to solve the problem. I am not prepared to state what local legislation would, at the present time, be beneficial.

New Hampshire. See answer under Connecticut for the New England states.

New York (#24 E). Legislation which should be enacted to make available the water powers of New York is a matter of too controversial a character to be set down here as anything other than a matter of personal opinion. The writer believes, however, that his own opinion is shared unanimously by those whose familiarity with the technical and commercial features of the hydroelectric power business makes their sentiments anything more than a matter of party politics. This opinion is that all public utility companies, being subject to the Public Service Commission of the state in matters of rates, capitalization, franchise territory, etc., should have the right of eminent domain over private owners of riparian rights at undeveloped power sites, and that this right should not be taxed by either the state or by any municipality, inasmuch as the rates for power are subject to state regulation by the Public Service Commission.

(#45 E). The development of water power from streams within the state would be stimulated by constitutional amendment and laws permitting the condemnation of lands for reservoir and other power purposes. The development of power from the Niagara and St. Lawrence Rivers would be helped by the passing of the Water Power Bill now before Congress, by an amendment of present restrictions limiting diversion from the Niagara River and by agreements between the governments of Great Britain and the United States.

Pennsylvania (#39 E). The legislation needed to encourage hydraulic development in this state is eminent domain for high tension transmission lines.

(55 E). There should be an amendment to the Act of July 2, 1895, adding to the powers granted under that Act the power to appropriate property necessary for transmission and distribution lines, compensation with security therefore to be provided for in the usual manner for the taking of property and should not give any power to take any natural resources or to take property for stations or other similar facilities and should further provide for a finding by the Public Service Commission that service to be rendered with the lines to be so built as necessary for the public's accommodation.

Rhode Island. See answer under Connecticut for the New England states.

Vermont. See answer under Connecticut for New England states.

Wisconsin (#43 E). We do not feel that there are any influences retarding the development of water power in this state. Therefore, we cannot suggest any legislation which would make water power development easier.

QUESTION—(A) "Would the development of such undeveloped water powers in your state offer any economies over the continued production of power by steam? (B) Could such water power, if developed in your state, successfully compete with power produced by coal?"

ANSWERS

Washington (#47 F). (A) It is probable that there would offer such economies as compared with the production of power by steam, provided the load factor of the consuming agencies was sufficiently high. (B) Such developments could probably compete successfully with power produced by steam provided the load factor is sufficiently high.

(#56 F). In answering this question I wish to point out first that there is very little production of power with steam outside of the lumber industry where wood refuse is used for fuel. Some of the utility companies have steam standby plants, and steam also to make up for water deficiency at certain times of the year but there is no extensive production of prime power by steam in the state. The question then resolves itself into one as to whether future power developments will be by water or by steam, and the answer will depend almost entirely on the extent to which the market for power develops and where it develops.

Practically all of the undeveloped water power is within feasible transmission distance of either Spokane or Seattle and the very considerable amount of undeveloped power on the Columbia River and some of its tributaries could be economically delivered to either city, providing the market grows to such an extent that a relatively large amount of power could be quickly absorbed when a new water power development was produced. To illustrate, to develop 200,000-hp. at Priest Rapids on the Columbia River would not in the present state of the market, be feasible and if the Priest Rapids site were the only one available in the state it would possibly be more economical to take care of increases of load by means of steam installations which would perhaps eventually be displaced by the development of Priest Rapids site, a contingency that would perhaps eventually be displaced by the development of Priest Rapids site, a contingency that would, however, involve the amortization of the investment in steam plants and might therefore be deferred for a long time. Assuming, however, the healthy growth of agricultural and industrial interests throughout the state, I believe that it is safe to say that their demands can be economically met by the development of the small powers first, and that eventually most or all the water power of the state would be used.

Oregon. Yes, there are a number of undeveloped water powers in this state which could compete successfully with steam.

California (#40 F). (A) Even at the present high price of labor and material water powers of this state undeveloped would, when developed, offer economies over the continued production of power by steam in a ratio of 1 to 2. (B) Yes. The production of oil has not kept pace with the increased demand and the price of approximately $1.56 per bbl. is almost 300 per cent of what it was three or four years ago.

(#44 F). I am not sufficiently familiar with conditions governing water powers available to answer with a satisfactory degree of precision. With regard to the undeveloped water powers controlled by Southern California Edison Company, I would state that the development of the part of the state served by this company cannot continue without these additional supplies of power. All additional agricultural and industrial development of the state must arise from the development and distribution of electric power. The companies now supplying fuel oil question their ability to provide sufficient supplies of oil for the present power requirements, and therefore water power must be brought in if the development of the state is to continue: The undeveloped water power projects controlled by the Edison Company can be constructed to produce power very much cheaper than would be possible through the medium of either coal or oil as fuel at the present market prices, and we anticipate an increase in these prices in the future, the price of oil having increased from 60 cents to $1.85 per bbl.

Colorado (#41 F). I believe in many places in the state power can be developed by water cheaper than by coal, even though we have an abundance of coal in Colorado and in many places in order to get a large volume of continuous power for twelve months in the year large storage reservoirs would have to be built. There are very few water power sites of any size that have not been largely developed. This means that any excessive future development would probably involve the use of induction generators and semi-automatic turbines with a great deal of transmission lines in exceedingly rugged country.

Montana (14 F). The development of the water power on the Clark's Fork of the Columbia River in Missoula and Flathead counties should result in the operation of two transcontinental lines by electricity rather than by steam and would successfully compete with power produced by coal. As a matter of fact, it is now stated that without the aid of the electric power in the operation of the mines at Butte, that such mines could not be operated at any considerable profit.

Nevada (#53 F). Only one large steam power plant in the state and water power is not available to compete with same.

Utah (#52 F). Aside from the use of coal in locomotives there is very little steam power used in Utah at present, since the cost of steam power is in excess of rates for water power.

Arkansas (#31 F). Do not believe at this time or until the demand for power becomes greater that any economies would be effected over the development of power generated by coal as fuel.

Connecticut (#28 F). The increased cost of coal has made commercially feasible the development of many small water powers which under the old basis of coal costs would not have been profitable. With a return to more normal building cost it is expected that there will be a good deal of hydroelectric development in the New England states, as many small water powers can now be developed at a profit.

District of Columbia (#16 F). We do not feel that any possible water power development would prove as satisfactory as the production of power by steam.

Georgia (#32 F). Water power in this state can successfully compete with power produced by coal. In fact, it is already being supplied to manufacturing industries at much less than it could be produced by coal and is displacing steam power plants wherever the water power is available.

Illinois (#57 F). The development of undeveloped water powers of Illinois offer economies over the continued production of power by steam because the cost of coal, transportation and labor have increased so greatly during the last few years. Further as the country's coal supply is being rapidly depleted, any future developments of water power which would save on the coal supply would be an economic asset to the country. Water power as developed at present in Illinois is successfully competing with power produced by coal.

(Continued on page 535)

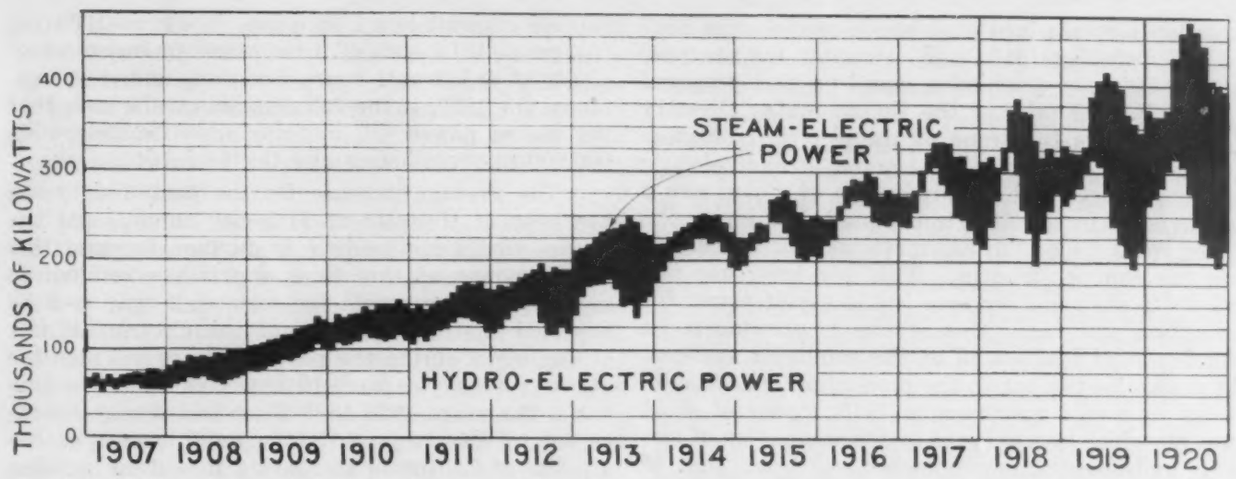


Chart of the mean monthly loads on California hydroelectric systems, showing the hydroelectric power produced and the production of steam plants. The increase of output during the summer months is due mainly to the increased use of power for irrigation pumping.

The Electric Power Situation in California

BY LESTER S. READY

(The power situation in California, where the irrigation load is increasing with such phenomenal rapidity, is making demands upon the electrical industry which necessitate hydroelectric developments and interconnections on an unprecedented scale. The following interesting survey of conditions is by the assistant chief engineer of the California State Railroad Commission.—The Editor.)

The most important problem now facing the electric utilities of California is that of supplying the growing demand for power being made upon their systems. The demands of consumers being served exceed the present supply and there appears to be a greater and more insistent demand for new service than ever before in the history of the state. This is due to many causes, including greater industrial activity, enlargement of agricultural acreage, greater use of electrical appliances and the increased cost of fuels used in the production of power. California has much undeveloped hydroelectric power, which is the logical source of supply to meet these increasing needs.

Consolidation of Utilities

The past years have seen a continuous process of consolidation of the electric utilities and interconnection of systems. Notable instances of this have been the merger of Pacific Light & Power Corporation, Ventura County Power Company and now the Mt. Whitney Power & Electric Company into the general system of the Southern California Edison Company; the absorption of several small companies into the Southern Sierras Power Company, and the consolidation with the Pacific Gas & Electric Company of the Oro Electric Company, Northern California Power Corporation and Sierras & San Francisco Power Company. Interconnection of systems has been completed to the extent that at the present time, from an operating standpoint, there are really only two systems serving California. The northern system extends from the Oregon line to Newman and King City, and consists of California-Oregon Power Company, Pacific Gas & Electric Company, Great Western Power Company and Western States Gas & Electric Company and certain smaller utilities. The southern system extends from Merced and Paso Robles south to the Mexican border and east to Nevada and consists of San Joaquin Light & Power Corporation, Southern California Edison Company, City of Los Angeles, Southern Sierras Power Company, San Diego Consolidated Gas & Electric Company and Los Angeles Gas & Electric Corporation. Before the convention of the National Electric Light Association meets at Pasadena on May 18th, 1920, these two vast systems will have been connected by a 60,000-volt transmission line south from Newman. When this is completed the electric utilities from the Oregon line to the Mexican border will practically be working in synchronism, joining in the service of the state across a distance of over 800 miles this vast system of 75 hydroelectric plants with an installed capacity of 470,000 kilowatts, 47 steam plants with a total capacity of 315,000 kilowatts, interconnected through 7,200 miles of high tension transmission circuits and serving a total of approximately 600,000 consumers.

This interconnection is of relatively small capacity. Within the near future sufficiently large capacity may be had to utilize any diversity of supply or demand. With this accomplished the electric power industries of the entire state may be considered as one great system.

Rapidity of Development

The growth of the electrical industry in California has been steady, increasing somewhat more rapidly during the last three years than formerly and giving prospects of increasing during the coming decade still more rapidly. An indication of this growth may be had from Chart No. 1, which shows for the electric utilities of the state the average

monthly kilowatt load as it has occurred since 1907 to and including 1919, with estimates for the year 1920. This chart, which is based on that prepared by Mr. F. H. Fowler of the United States Forestry Service, shows the trend of the electrical business for the past 14 years. The amount of hydroelectric power produced and the production of steam power plants is set forth. It is to be noted that during the latter years the output has materially increased during the summer months. This has been due primarily to the rapid increase in the use of power for irrigation pumping. This service is growing to be the dominant load on all of the combined systems. As shown by the curve, the production of power by steam reached a maximum in 1913, a year of short rainfall, which was followed by the completion of two large hydroelectric developments, one being that of the Pacific Light & Power Corporation on Big Creek, Fresno county, and the other the installation of the Drum Power Plant of Pacific Gas & Electric Company. A second marked increase in steam production commenced in 1917 and has extended through to the present year. This is a result of the reduction in hydroelectric output due to a series of dry years, the practical cessation of power development during the war period of 1917-18, and the delay in completion of new developments commenced thereafter. The total power output during the year 1915 to and including an estimate of 1920 has been as follows:

ELECTRIC OUTPUT
CALIFORNIA ELECTRIC UTILITIES

Year	Hydro Output M. Kw-hr.	Steam Output M. Kw-hr.	Total M. Kw-hr.	% Increase
1915	1,857,700	378,800	2,236,500	
1916	1,995,200	351,100	2,346,300	5%
1917	2,097,500	485,000	2,583,000	10%
1918	2,162,300	728,500	2,890,800	12%
1919	2,246,900	966,300	3,213,200	11%
1920	2,222,700*	1,394,000*	3,616,700*	12%*

*Estimated

The percentage of total production by steam will, as noted, reach a maximum in 1920 of approximately 38% as against an average during normal conditions of from 15 to 20½.

Increase in Demand

The growth of load has so exceeded the increase in plant development during the past three years that the utilities will not be able to meet the demands made upon them by existing consumers and have found it necessary to discourage and practically refuse new business. A general analysis of the conditions show that the state is at least 25,000 kilowatts short of the minimum plant capacity needed. Even with the operation of all steam plants available, regardless of efficiency or cost, curtailment of use equal to approximately 10% of the load will be necessary in the northern district. In addition to this actual shortage of plant capacity and output, the electric utilities are at the present time at least 100,000 kilowatts short of the most economical hydroelectric capacity in view of present load conditions and relative cost of steam power. The plans for the coming years must include, in addition to meeting the actual growth of demands, the further installation of this additional hydroelectric capacity.

The average growth in the demand for power prior to 1918 was at the rate of approximately 200,000,000 kilowatt-hours per year. The growth during the years 1918 and 1919 increased to in excess of 300,000,000 kilowatt-hours per year, and it is estimated for 1920, if the full demand can be met, that the use of power will increase approximately 400,000,000 kilowatt-hours over the year 1919.

The average increase for the past four years has been at the rate of 11% per annum, and the special conditions tending to further increase this use of power at this time, which has resulted in unprecedented requests for service, it may well be expected that the business of the electric utilities of California during the next five years will increase at the rate of at least 12% per annum. On this basis, the years 1920 to 1925 inclusive may be expected to see a growth in the requirements of the utilities of California amounting to a total increase of approximately 75 per cent.

From a study of the power loads of the two great systems now serving the state it appears that the load factor of the combined systems when fully interconnected will be between 60 and 65 per cent. No material increase in the load factor is to be contemplated under normal conditions of operation and the new business to be taken on may be expected to be at a load factor not in excess of 65 per cent. The growth of load of approximately 12% per annum will result in a further increase in the simultaneous demand of from 65,000 kilowatts to 85,000 kilowatts per year.

Increasing Plant Capacity

It has been found necessary, due to variation of precipitation from year to year, to increase plant capacity to a greater extent than the increase of simultaneous demand. At present this ratio of capacity to demand is approximately one and one-quarter and this figure has been found to represent practically the minimum.

During the next five years the electric utilities in California must contemplate an increase in the plant capacity of from 80,000 kilowatts to 100,000 kilowatts per year in order to meet the growth in load. In addition, the next five years should see the increasing of the relative capacity of hydroelectric power by at least 100,000 kilowatts to reduce the present excessive steam production, bringing the total to 500,000 kilowatts or a minimum per year of 100,000 kilowatts.

There is at present invested in physical plant and system of the electric utilities of California approximately $240,000,000, covering the installation from the diversion of water in the mountains to the consumers' meters, and representing a total investment of approximately $400 per kilowatt of simultaneous peak. The cost of construction of electric power plants, transmission and distribution systems is now from 50 to 100 per cent higher than when existing systems were installed, and, if it be assumed that these higher costs continue for the next five years without any further increase, the utilities of California must be prepared to expend on new developments and in extension of their existing systems between $40,000,000 and $50,000,000 per annum.

The work before the electric utilities is no small task, especially in view of the high cost of money and difficulty of obtaining sufficient funds. The present year will, however, see the completion of 90,000 kilowatts of hydro plant capacity and 25,000 kilowatts of steam. The year 1921 should see at least an equal amount added.

The past three years of drought have made clear to those affected the importance of the storage of water for irrigation and power purposes. There has been a large increase in the acreage depending upon irrigation for the production of crops and the effect of the short precipitation upon the operation of power plants has been such as to clearly set forth the need of additional storage in connection with those plants. The coming few years will in all probability see increased activity in the development of storage for irrigation purposes.

Practically all streams on which power may be developed are being used to their limit for irrigation purposes. Cooperation between the power and irrigation interests should result in material benefit to both and make more completely available the most valuable natural resource of the state.

The development of power requiring such large expenditures must be carried on with determination and special care as to cost. Comprehensive studies of their needs must be made by the utilities and plans worked out for the most economical developments in order that the best may be had. The more economical developments should be made regardless of control or ownership. Through the state agencies regulating the electric and water service, complete and comprehensive studies of the water and power possibilities of the various streams should be made and developments so co-ordinated that the greatest good may be obtained for the state through the more complete use of its natural resources. Petty differences between utilities must be buried, business jealousies forgotten, and every effort exerted to the end that the extension of service may be made on a sound basis and with the least total cost to the public.

Electrical Development in the San Joaquin Valley

BY A. G. WISHON

(That the West progresses in the same proportion as its hydroelectric development is a principle which is fully substantiated by conditions in the San Joaquin Valley. To meet the tremendous demand for power which is coming in from this district, extensive hydroelectric developments and improvements are going rapidly ahead. The following account is by the general manager of the San Joaquin Light & Power Corporation.—The Editor.)

Located in the heart of the San Joaquin Valley, one of the wealthiest agricultural regions in the West, the San Joaquin Light & Power Corporation serves a territory that is entirely dependent upon the development of electricity for its growth and prosperity. At the present time, the power company's statisticians figure that the agricultural and electrical possibilities of the San Joaquin Valley are less than 10% developed.

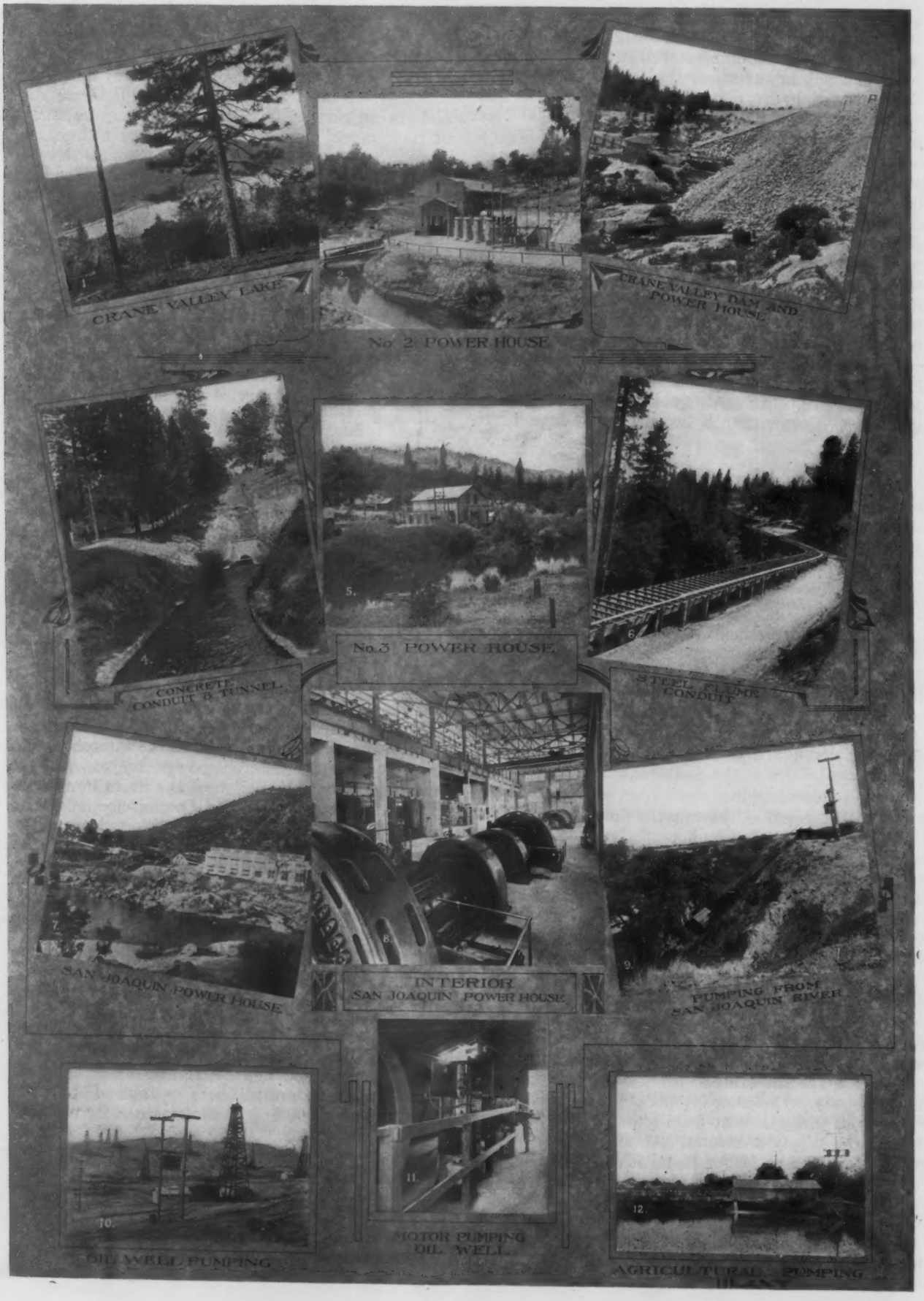
With the end of the war the San Joaquin Light & Power Corporation had a maximum generating capacity of 63,000 kw., from nine hydroelectric plants and three steam plants. About the first of June of the present year a new 12,500-kw. addition to the natural gas burning steam plant at Bakersfield will be placed in operation. By the middle of September the new 30,000-kw. Kerckhoff hydroelectric plant on the San Joaquin river, forty-five miles from Fresno, will be in operation.

Preliminary work has been started on the new natural gas burning steam plant to be erected in proximity to the recently discovered natural gas fields near the Elk Hills in the west side oil fields of Kern county. The company plans the installation as rapidly as possible of at least four 15,000-kw. units, and if the supply of natural gas is sufficient to warrant additional or larger installations, the company plans to include these provisions. All materials and equipment for the first unit have been ordered and the company is making a determined effort to place the plant in operation before the end of 1920. While undoubtedly the plant will be operating before the end of this year, it will probably come too late to be of material assistance in handling the power shortage during the forthcoming agricultural pumping season. Nevertheless, it will be a plant of strategic importance, and the fact that it will generate power by means of burning natural gas, at greatly reduced cost as compared with crude oil fuel, this plant promises to play an important part in the interchange of power between the different power companies of the state, under the jurisdiction of the State Power Administrator and the Railroad Commission, resulting from the interconnection of the different transmission systems.

Therefore, the building program of the San Joaquin Light & Power Corporation will place in actual operation in the year 1920 new power houses with a combined output almost equal to the total generating capacity of the company at the beginning of the year.

Kings River

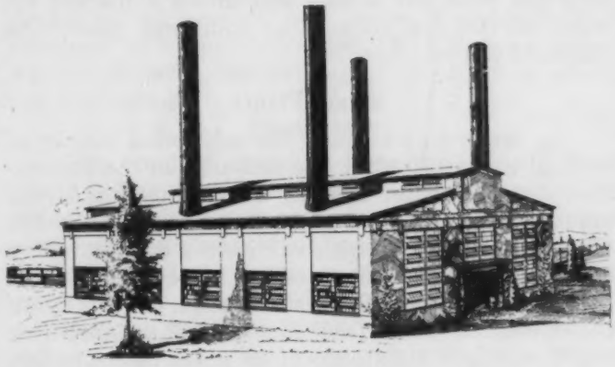
The big hydroelectric development of the San Joaquin Light & Power Corporation is the Kings River project, the lower power house of which will be less than thirty miles from the center of the company's transmission and distribution system. This project will have an ultimate output of between 270,000 and 300,000 hp. The estimate of its ultimate cost is between $50,000,000 and $55,000,000. All preliminary engineering has been completed. More than thirty miles of the fifty miles of roadway necessary to open up the country have been completed and two bridges over the river are installed. The company's original plans provided for prosecution of the Kings River job in 1921 and for the completion of the first unit at the end of that year.


CRANE VALLEY LAKE
No. 2 POWER HOUSE
CRANE VALLEY DAM AND POWER HOUSE
CONCRETE CONDUIT & TUNNEL
No.3 POWER HOUSE
STEEL FLUME CONDUIT
SAN JOAQUIN POWER HOUSE
INTERIOR SAN JOAQUIN POWER HOUSE
PUMPING FROM SAN JOAQUIN RIVER
OIL WELL PUMPING
MOTOR PUMPING OIL WELL
AGRICULTURAL PUMPING

In view of the shortage of power and the opportunity to develop a supply by means of the natural gas discovery in the Kern county oil fields by the erection of a steam plant more speedily than by the development of a hydroelectric project, the company diverted the finances intended for the first unit of the Kings River development to the Oil Fields steam plant, in order to meet the increasing demand for more power as speedily as possible.

Reservoir	Location
Lake Wishon	N. Fork Kings River, Coolidge and Dusy Meadows
Meyer Lake	Deer Creek at Buck Meadows
Peart Lake	N. Fork Kings River, Dinkey Meadows

The Kings River development will be located on the North Fork of Kings River in the Sierra National Forest, in Fresno county. It will have a total reservoir storage of 202,200 acre feet and a power capacity of 271,250 hp. The storage is embraced in three reservoirs, as shown in the table above.



Sketch of the new Oil Fields steam plant of San Joaquin Light & Power Corporation. The first installation will be a 15,000-kw. turbine, and the plant will feed into the 110,000-volt transmission system at the McKittrick sub-station.

The power will be derived from seven plants, located as follows: Wishon, on the North Fork of Kings River at the Coolidge and Dusy Meadows; Haas on the North Fork of Kings River; Peart on the North Fork of Kings River at Dinkey Meadows; Meyer, in the Deer Creek Basin; Farnham, on the west branch of the North Fork of King's River; Kings River, on the main Kings river at the head of the proposed Pine Flat Reservoir. The major power house of Balch, which has 45% of the total power capacity of the development, is located 54 miles, by highway, easterly of Fresno at the junction of the North Fork of the Kings river and the west branch of the North Fork of Kings river, and is the geographical hub of the entire development.

This development will have, so far as is known, the two highest heads in the United States and with few exceptions, in the world. Balch Power House, with a head in excess of 2500 feet, will be the highest, with Haas next with 2475 feet. Wishon will have a head of 235 feet and the Kings River a head of 410 feet, making the total head of these four power houses on the North Fork of Kings River 5,620 feet, in a distance, as the crow flies, of six and one-half miles. The power houses are listed in the table at the bottom of the page.

Elevation Above Sea Level	Capacity Acre Feet	Drainage Area Square Miles	Dam Height	Dam Top Length
6,550 ft.	128,000	178	250 ft.	4,100 ft.
6,850 ft.	21,000	19	190 ft.	1,600 ft.
5,650 ft.	53,200	65	315 ft.	900 ft.

Crane Valley

Additional developments, or refinements, in the Crane Valley district are to be begun this year. The first of these will be the installation of a 9,000-hp. automatic plant to be known as Kerckhoff Jr. Power House, 400 feet below the recently completed Kerckhoff Dam. This plant will utilize the overflow over Kerckhoff Dam, under an 80-ft. head, during the periods of high stream flow of the San Joaquin river. It will be in operation approximately five and one-half months of the year and will increase the efficiency of the company's plants on the San Joaquin river by taking advantage of run-off that otherwise would go to waste. Efforts were made to install this plant during the spring of the present year, but it was impossible to obtain deliveries of equipment. This plant will in all probability deliver its output into the 60,000-volt transmission system.

The raising of Crane Valley dam 12 feet to provide 17,000 acre feet of additional storage capacity,

The Kerckhoff dam on the San Joaquin river near Fresno, showing intake of 17½ x 17½ tunnel line, incline and camp.

Power House	Capacity	Elevation Above Sea Level	Head	Diversion	Tunnel Length	Tunnel Section	Penstock
Wishon	6,670 hp	6,315 ft.	235 ft.	400 sec. ft.			700 ft.
Haas	82,670 hp.	3,825 ft.	2,475 ft.	400 sec. ft.	7.4 mi.	12 ft.	7,000 ft.
Balch	124,000 hp.	1,310 ft.	2,500 ft.	400 sec. ft.	5 mi.	12 ft.	
				200 sec. ft.	4.1 mi.	9x7½ ft.	6,550 ft.
Peart	2,600 hp.	5,385 ft.	265 ft.	150 sec. ft.			300 ft.
Meyer	6,670 hp.	5,385 ft.	1,465 ft.	50 sec. ft.	1.1 mi.	6 ft.	2,400 ft.
Farnham	26,670 hp.	3,825 ft.	1,545 ft.	150 sec. ft.	4.3 mi.	7½ ft.	
				50 sec. ft.	1.6 mi.	9x7½ ft.	4,600 ft.
Kings River	22,670 hp.	890 ft.	410 ft.	650 sec. ft.	3.7 mi.	14 ft.	950 ft.

at a cost of more than $1,000,000, is the second step in the program. Brown's Creek Ditch will be built, diverting 14 square miles of watershed into Crane Valley as a part of this improvement.

The output of No. 3 Power House will be increased by the installation of an additional 2,000-kw. unit and the enlargement and cementing of the No. 3 ditch to increase its carrying capacity from 100 second feet to 160 second feet.

Other Plant Improvements

The output of Tule River Power House will be increased to maximum capacity by the completion of the Nelson Branch conduit. This will give approximately 3,000 additional kilowatts, practically doubling the output of the power house. All engineering for this work has been completed and the construction work is one of the early sections of the 1921 building program.

Re-building of the Kern River plant so as to utilize a larger amount of water by the extension and enlarging of the conduit system which will provide a higher head, has been provided for at the first time the company is enabled to do without the output of the present 3,750-kw. unit now in operation. The plant will be increased to 12,500 kw. at an expense of between $2,500,000 and $3,000,000, but the work must necessarily be postponed until the construction program catches up to the demand. The present unit, which will be replaced by one almost four times as large, will be moved to another part of the company's system for installation.

The company is at present negotiating for the leasing of the plant serving Mariposa, Mt. Bullion and Bear Valleys in Mariposa county. By the construction of four miles of line between the Kittridge Power House and the plant of the Mariposa Company at Bagby a very good prospective territory will be added to the mining load of the company.

110,000-Volt Transmission Lines

With the completion of the Kerckhoff Power Plant, the inauguration of 110,000-volt transmission service will be begun by the company between the Kerckhoff plant and the McKittrick sub-station where distribution is made for the west side oil fields of Kern county. This new high tension transmission line will have a carrying capacity of 50,000 kilowatts. It is being erected on steel cross-arms on 60-ft. wooden poles. The aluminum wires are 5/8-inch in diameter.

There are three-sub-stations, stepping the voltage down from 110,000 volts to 70,000 volts. The first of these sub-stations is located close to Sanger. The second sub-station is located at Corcoran and the third at McKittrick. At each sub-station there is installed a bank of four 5000-kw. transformers which reduces the voltage from 110,000 to 70,000 and also 11,000, so that distribution can be made at 11,000 volts. At each sub-station site there will be a concrete sub-station for the housing of the switches, metering equipment, etc., and a cottage for the attendant. The total expenditure on the line and sub-stations will amount to about $750,000.

Additional 110,000-volt transmission service is planned from the Kerckhoff plant through the Northern division of the company's territory, ultimately tying in with the Pacific Gas & Electric Company at Modesto. Unless prospects for an additional supply of natural gas in the Santa Maria oil fields materialize sufficiently to warrant the company to increase the size of its steam plant now being operated at Betteravia near Santa Maria, the 110,000-volt transmission line will be extended from the McKittrick sub-station into the Santa Maria oil fields. This territory is on the system of the Midland Counties Public Service Corporation which purchases power wholesale from the San Joaquin Light & Power Corporation. The Midland serves a territory of great potential wealth and offers a market for much service just as soon as additional generating facilities can be provided.

Steam Plants

In order to transport the additional supply of natural gas required by the new unit in the Bakersfield steam plant the Midway Gas Company is laying approximately 50 miles of 12-inch line from the Elk Hills to Bakersfield which will have a daily carrying capacity of approximately 25,000,000 cubic feet. At the present time the Bakersfield steam plant is using the 6,000,000 cubic feet capacity of a 6-inch line which was laid a distance of 26 miles last summer, connecting up with the Midway Gas Company line between Kern county oil fields and Los Angeles 26 miles south of Bakersfield.

The present equipment of the Bakersfield steam plant consists of two turbo-generators having a capacity of approximately 12,500 kilowatts. The new equipment to be installed will be a single unit Allis-Chalmers turbo-generator of 12,500-kw. capacity of the very latest design, constructed for operation under 250 pounds steam pressure. The necessary boiler installation will consist of a battery of ten 822-horsepower Sterling boilers manufactured by the Babcock & Wilcox Company. These boilers will have a capacity of approximately 15,000 kilowatts.

The current will be generated at 2,300 volts, and will step up through a bank of three 70,000-volt transformers for delivery on to the high line transmission system of 60,000 volts.

The first installation in the new Oilfields Steam Plant will be a 15,000-kw. turbine. There will be an accompanying installation of eight 825-horsepower boilers to maintain 250 pounds pressure at 125 degrees superheat. This unit will consume approximately 9,000,000 cubic feet of natural gas daily. Each additional unit in the Oilfields plant will require an additional 9,000,000 cubic feet of gas. The four units will be installed as rapidly as possible, providing the natural gas supply warrants the investment. The cost of the initial unit, including building, building site and headquarters buildings will be $1,769,850. It is estimated that each additional unit will cost approximately $1,000,000. The plant will feed into the new 110,000-volt transmission system at the McKittrick sub-station.

Hydro-Electric Development on the Feather River

BY J. H. ANDERTON

(The industrial development of California is involving a demand for electric power which is increasing faster than the power companies supply it. One of the largest developments being undertaken to meet the growing need, is described in the following article by the chief electrical engineer of Stone & Webster Co.—The Editor.)

With perhaps one exception, nowhere on the continent of North America can there be found a river having such wonderful possibilities for the development of electrical energy as the Feather River, one of the great natural drainage streams of the Sierras. Situated for almost its entire length in a gorge of unvarying scenic beauty, where the water tumbles in a series of rapids for mile upon mile, and paralleled by one of our great transcontinental railways, it is not only a delight to the eye of the modern traveler, but a fascinating object of study for the engineer.

Topography

The principal source of the river lies in Plumas County, largely in a natural basin known as Big Meadows, into which numerous small tributaries flow from the slopes of Mt. Lassen and other notable peaks to lend their volume to the North Fork or main branch of the stream. The principal source of power on the river is the North Fork, as will be noted from the relief map which shows only one power development projected below the junction of the two forks. The total distance along the river from Big Meadows to the junction with the Sacramento is approximately 140 miles. The part of the river suitable for power development is that between Big Meadows, the source, and Oroville, a distance of approximately 75 miles, and it is this latter which

Looking toward the site of the Caribou power house No. 2, on the system planned by the Great Western Power Company on the North Fork of the Feather River.

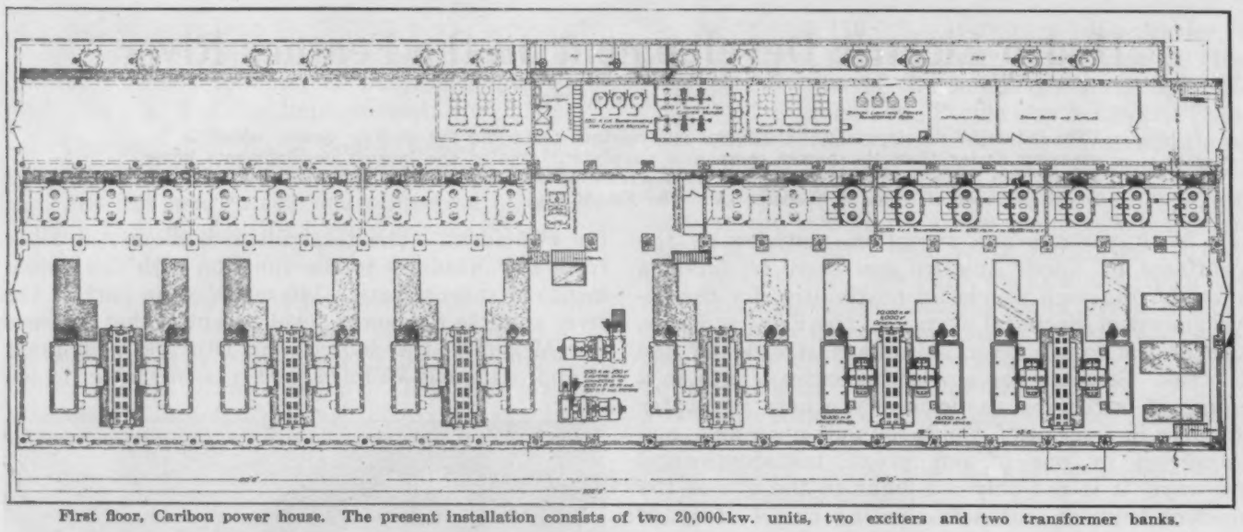
is embraced within the property of the Great Western Power Company of California.

Looking down the North Fork of the Feather River. The total fall in the river from the Big Meadows dam to Oroville is 4,285 ft.

The total fall or natural head in the river from the spillway of the Big Meadows dam to Oroville is 4,285 feet, the elevation at Oroville being only 170 feet above sea level. The drainage area or watershed tributary to Big Meadows is 504 square miles, practically all of which is favorably located for maximum conservation of the precipitation over the neighboring Sierras. The drainage area tributary to the River between Big Meadows and Oroville, is approximately 3,000 square miles. The total average annual runoff in the Big Meadows basin alone over a period of thirteen years is 842,000 acre feet, with the usual occasional flood peaks much in excess of this.

Power Possibilities

Considering only the possibilities of the Big Meadows drainage area and assuming the 72 per cent of the total head between Big Meadows and Oroville is made available at the water wheels with an efficiency of generation of 80 per cent and 70 per cent load factor, the ultimate development would be approximately 350,000 kw., and it should be noted that this calculation does not take into account the drainage area tributary to the river below the Big Meadows dam. Realizing the tremendous possibili-



First floor, Caribou power house. The present installation consists of two 20,000-kw. units, two exciters and two transformer banks.

ties of this source of energy, the Great Western Power Company some years ago determined upon a comprehensive plan of development which should have for its ultimate object a suitable number of properly located power houses and trunk line transmission and distributing systems which would deliver this power to the markets of California, more particularly for use in the San Francisco Bay District.

Travelers through the Feather River Canyon may see side by side for miles two remarkable examples illustrating the progress in the art of transportation and engineering—one the old Caribou Trail made famous in literature, winding around the mountains, limited in location and capacity and traveled by the pioneers and gold hunters of bygone days, a majority of whom used the very water which, unknown to them, held within itself potential values enormously in excess of the gold which they uncovered by its use; the other, the modern effort of engineering in the art of transportation, practically unlimited as to location and capacity—in short, the modern electric transmission line.

The first step toward harnessing the water powers of the Feather River on a large scale was undertaken when a dam was built and a tunnel driven through the rock to divert the water from Big Bend in order to permit gold mining operations being carried on in the bed of the river. Later the Great Western Power Company acquired the tunnel and water rights of the gold mining company and formulated plans for utilizing them in an hydro-electric development. In 1909 the Big Bend power house of the company began generating electrical energy and ever since then has been transmitting it 154 miles to Oakland at 100,000 volts. This development constituted the earliest 100,000-volt transmission system in the world.

Plans for Future Development

With the growth of demand for electrical energy, steps were taken toward the development of the system and a comprehensive plan laid down in 1910, when work was commenced upon the construction of a dam which would conserve and control the flood waters of the river at Big Meadows. This dam is an earth-filled structure 600 feet long and contains approximately 300,000 acre feet of water, which thus forms Lake Almanor, having an area of 15,500 acres and an average depth of 19.5 feet. By raising the crest of the dam 28 feet, the capacity of the lake might be increased to approximately 1,250,000 acre feet, with an area of 27,000 acres. Since the average runoff into the Big Meadows basin is given as 842,000 acre feet per year, the wisdom of a dam capable of impounding 1,250,000 acre feet of water might be questioned at this time. However, the rapidly increasing value of water power to our economic and industrial advancement is such that methods by which the occasional flood year waters may be conserved to give a more nearly uniform flow will have to receive serious consideration. When this time comes, the Great Western Power Company will be in an excellent position to provide properly for it.

In general, the ultimate scheme of development contemplates a series of seven power houses located at strategic points on the river and all successively utilizing the controlled waters of Lake Almanor, amplified by the natural runoff of the watershed between the lake and the last power house, which is near Oroville. As at present outlined, the following notations will apply to each of the power houses for the ultimate development:

Power House	Location	Transmission distance from San Francisco Miles	Length of Tunnel Feet	Maximum Head Feet	Capacity Kw.	No. of Units
No. 1 Butt Creek	Butt Creek, near south portal of Tunnel from Lake Almanor	225	11,200	334	25,000	3
No. 2 Caribou	North Fork of River, 10 miles from Lake Almanor	195	22,950	1,008	120,000	6
No. 3	North Fork of River, 18 miles from Lake Almanor	187	10,500*	450	60,000	4
No. 4	North Fork of River, 38 miles from Lake Almanor	167	10,500*	650	93,000	5
No. 5	North Fork of River, 50 miles from Lake Almanor	155	17,000*	400	60,000	4
No. 6 Big Bend	North Fork of River, 58 miles from Lake Almanor	147	15,038	435	80,000	8
No. 7	Below junction of North and East Forks of River, 75 miles from Lake Almanor	130	16,000*	270	48,000	4

*Approximately.

The total available river head utilized in the above developments is 85 per cent; the total kilowatt development, 486,000.

Financing

Of the above total hydro-electric development the company now has in operation and under construction a total of 105,000 kw., leaving a balance for possible future extensions of 381,000 kw. The estimated expenditures required for the complete development of the river, excluding that already provided for, are as follows:

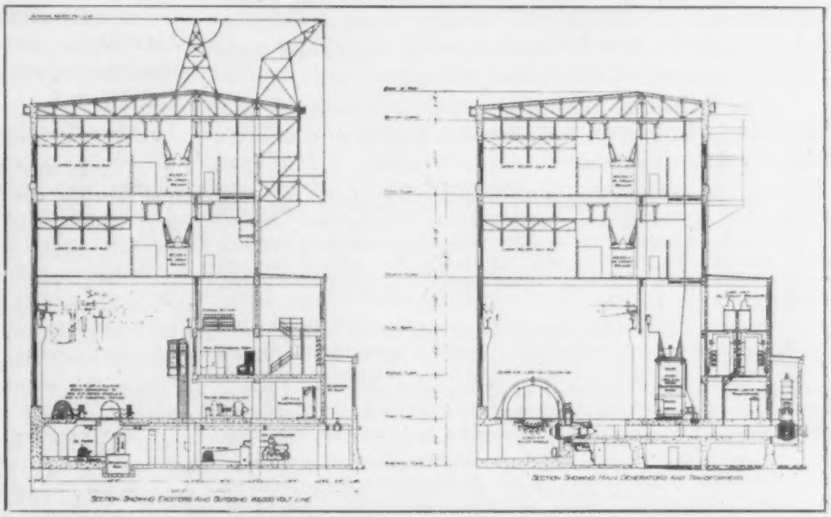
Power House No. 1	$ 5,000,000
Power House No. 2, to complete	16,000,000
Power House No. 3	12,000,000
Power House No. 4	18,600,000
Power House No. 5	12,000,000
Power House No. 6, to complete	3,000,000
Power House No. 7	9,600,000
Total	$76,200,000

The rate at which this money will be required will, of course, depend primarily upon the general industrial development of the district which the Great Western Power Company serves, and, secondarily, upon the activities of competing companies. However, the rate of growth of the company, as shown by the demand upon it for a number of past years, is a fair indication of its future requirements and upon this basis, indications are that average yearly monetary requirements for extension of hydroelectric generating equipment during the next ten years will be approximately $1,500,000. The above figure presupposes a growth consistent with that of the past years. It does not include any provision for transmisssion, distribution or steam reserve, and on the assumption that such projects as the much discussed trunk line railway electrification or other similar projects should develop, the necessary expenditures will, of course, be proportionally increased.

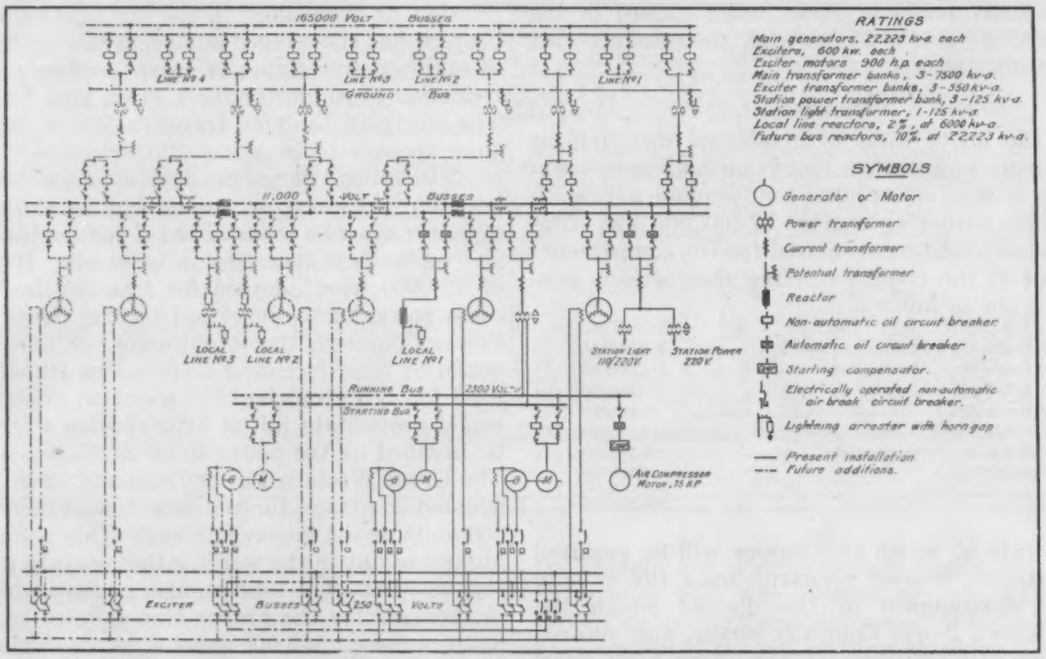
Transmission Requirements

Among the items of interest in connection with the ultimate development of the river are the transmission lines required to conduct this power to market. The remarkable success of high voltage transmission, as exemplified in the Big Creek 150,000-volt project, has encouraged engineers to consider the use of still higher voltages in order to effect yet greater reduction of conductor for a given load transmitted. The electrical limit of transmission at the present time appears to be about 220,000 volts. However, at this voltage large conductors must be used to keep down the corona losses, and enormous blocks of power must be transmitted if reasonable first cost and economical operation is to result. If a voltage of 220,000 were adopted for transmitting the ultimate power to be developed by the Great Western Power Company, the total number of lines required would be four, including a spare line which could be used for synchronizing, but adoption of this voltage would necessitate initial expenditures which cannot be justified by the power to be developed at present. The Great Western Power Company have therefore adopted a voltage for the new development of 165,000 volts at the generating end. This voltage is the highest of any in the world, either operating or under construction. The total number of lines which would be required for the proper transmission of the ultimate power at 165,000 volts is seven, including the spare line which can also be used for a synchronizing line.

The regulation of the system will necessarily be controlled by synchronous condensers, or their equivalent, and the total kva, required for the 165,000-volt system will be approximately 280,000. For a 220,000-volt system, the initial condenser equipment required for proper regulation would be quite large compared to the capacity of the generating equipment. The ultimate condenser requirements, however, for the total development at this voltage would be much less than 165,000 volts. The reduction in the number of lines and synchronous condenser capacity must not, however, be construed as sufficient basis of comparison between the two voltages, since 220,000-volt lines cost considerably more to build than lines for 165,000 volts, also switching equipment, transformers and their housing are considerably more expensive for the higher voltage. Nevertheless, for a development which involves sufficiently



Composite sections of Caribou power house. The present length of the power house is 176 ft., but the length of the ultimate building will be 308 ft., and it will be designed to accommodate when complete, six 20,000-kw. units, six 22,500-kva. transformer banks, four 60,000-kva. 165,000-volt transmission lines and three local distributing lines.



Scheme of connections, Caribou power house

large blocks of power from the outset, greater economy would result through the use of 220,000 volts.

The Caribou Development

At present the company has under construction the development for power house No. 2, known as Caribou. This power house will have an ultimate capacity, as previously mentioned, of 120,000 kw. in six units. The present installation will consist of two units and provision for a third with the usual auxiliaries.

The course of the water for the Caribou development is from Lake Almanor through tunnel No. 1 to Butt Creek, where the stream bed of the creek is utilized for a distance of 8 miles, terminating at a diversion dam, which incidentally produces the largest forebay in California. The natural flow of Butt Creek is, of course, added to that coming through tunnel No. 1 from Lake Almanor. From Butt Valley the water flows through tunnel No. 2 to the crest of the ridge behind the power house, where it empties into tunnel No. 3 and thence through individual penstocks for each of the water wheels.

The principal hydraulic work consists of the three tunnels, known as 1, 2 and 3, having the following characteristics:

Tunnel No. 1.—Located between Lake Almanor and Butt Creek. Area, 40 square feet. Section rectangular. Slope, 1 per cent. Length, 11,200 feet, with three shafts. Lining, part concrete and part wood. Capacity, 800 second feet of water. Equipped with two 7-foot electrically controlled gates at its entrance.

Tunnel No. 2.—Located between the south end of Butt Valley and the crest of the river gorge. Area, 63.62 square feet. Section, circular. Diameter, 9 feet. Slope, .8 per cent. Length, 9,200 feet. Number of shafts and adits, 2. Lining, concrete. Capacity, 1,000 second feet of water. Equipped with a nine foot electrically controlled gate at the entrance.

Tunnel No. 3.—Located between the crest of the gorge and the power house below. Area, 63.62 square feet. Section circular. Diameter, 9 feet. Length, 2,550 feet. Number of adits and shafts, 2. Lining, combination steel and concrete. Capacity, 1,000 second feet of water. This tunnel drops with a slope of 37 degrees to the elevation of the water wheels and thence runs horizontally for 300 feet to the face of the wall of the gorge where it empties into the horizontal penstocks.

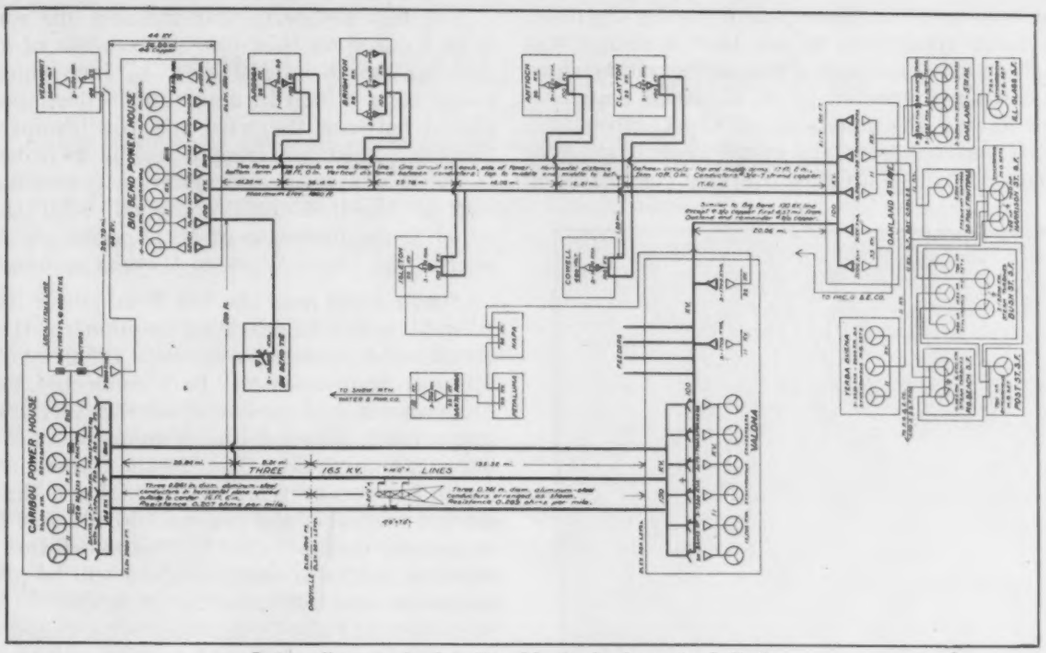
Near the lower end of tunnel No. 2, about 100 feet from the entrance to tunnel No. 3, there will be a surge chamber 200 feet deep from the ground surface.

In order to provide adequate transportation for men and materials to construct the tunnels and power house, 9.25 miles of standard gauge railway was built connecting with the Western Pacific Railways at Howells. The take-off at this point necessitates a timber trestle and bridge containing 1,000,000 feet of timber. This railway terminates at the power house and is built in the river gorge. A series of three motor operated incline railways is built from the gorge into Butt Valley and to the summit overlooking the lake. These inclines have a total length of one mile and a grade varying from 25 to 50 per cent. A narrow gauge railway was also built 10.5 miles long through Butt Valley to the south portal of tunnel No. 1.

Caribou Power House Equipment

The power house is a reinforced concrete structure having the following dimensions: Height, 105 feet; width, 104 feet; present length, 176 feet; ultimate length, 308 feet.

The present building is designed with the future extension in view and will accommodate three 20,000-kw. units, three 600-kw. exciters, three 22,500-kva. transformer banks, two 60,000 kva., 165,000-volt transmission lines, one 6,000-kva., 11,000-volt outgoing line and miscellaneous auxiliaries. The ultimate building is designed for a total of six 20,000-kw. units, six 22,500-kva. transformer banks, four 60,000-kva., 165,000-volt transmission lines and three



System diagram showing the ultimate development of Caribou

local distributing lines. The present installation consists of two of the 20,000-kw. units, two exciters and two transformer banks. The 20,000-kw. units will each consist of two overhung impulse type wheels, having 21 buckets, to operate under a head of 1008 feet with a speed of 171.4 r.p.m. Incidentally, each bucket weighs 2200 pounds. The jet diameter is 11 inches. Regulation is by means of two governors, one on each nozzle, actuating a direct operated needle by oil pressure. Two automatic pressure relief valves are also provided with each unit designed for operation by the governors to discharge water directly into the tail race in response to a predetermined pressure rise.

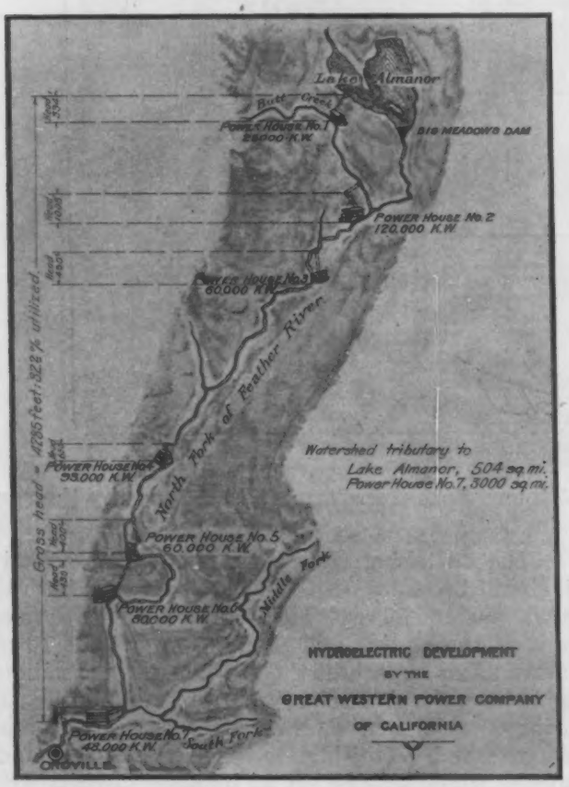
The generators are rated 22,223 kva. at 90 per cent power factor, three phase, 11,000 volts, Y connected. The generator windings are brought out of the machine at both ends for differential protection against internal breakdown. The shaft of the unit weighs 20 tons and has a diameter at the bearings of 24¾ inches. Each of the two bearings is 72 in. long. The total weight of the revolving element of the unit is 170 tons and of the whole unit is approximately 290 tons.

The transformers are of the usual oil-insulated water-cooled type. Each transformer is of 7500-kva. capacity and will be delta connected on the low tension side for 11,000 volts and Y connected on the high tension side for 165,000 volts, with the neutral grounded through indicating instruments and alarm devices. These transformers are also equipped with the new oil conservator and will have imbedded temperature coils. It is of interest to note that the transformers for the Big Creek system are each rated 5833 kva. at 6600 to 86,600 volts (150,000 volts Y), are 26 feet high over the bushings and weigh 75 tons each with oil, while the Caribou transformers are 7500-kva., are the same height and weigh only 45 tons. Both transformers were made by the same manufacturer.

The switching equipment consists of selective oil circuit breakers with duplicate busses on both the 11,000 and 165,000-volt sides. The ultimate development of the station will require two sets of 10 per cent reactors in each of the low tension busses in order to keep the short circuit currents within the rupturing capacity of the oil switches. Careful computations have been made as to the magneto-mechanical stresses which may be set up by short circuits when the system is enlarged with the result that bus insulators spaced on an average of 28 inches are designed for a mechanical stress of 1200 pounds in any direction. Each of the 11,000-volt and 165,000-volt busses are entirely isolated from its duplicate and each bus and switch room is again divided into sections embracing one generator and one transformer bank on the low tension side, and one individual switch on the high tension side. It may be mentioned that each 165,000-volt oil switch occupies a space of 24 feet 10 inches by 9 feet by 17 feet high without clearance and weighs 26 tons complete with oil.

The two 600-kw. exciters are each capable of exciting the fields of three generators. They are designed as three unit sets for operation by water wheels or by induction motor. The third exciter will be motor operated only. The exciter voltage, and therefore the station voltage, will be controlled by Tirrell regulators acting directly upon the exciter field rheostat. These exciters are the largest in capacity that can be controlled directly by regulators without the interposition of secondary exciters. Some slight modifications were made in the regulator in order to avoid using secondary exciters in this plant and no difficulty is expected in controlling the exciter voltage from zero to maximum.

Extreme care was taken before placing the order for the main generators to see that a design was presented which would not give a self-exciting characteristic when connected to an unloaded transmission line having the constants of the Caribou line. That is, it was important to guard against extreme and prolonged over-voltage or overload conditions on



The principal source of power on the Feather River is the North Fork, the part between Big Meadows and Oroville being specially suitable for hydroelectric developments as planned by the Great Western Power Company.

the generators, even though the excitation were reduced to zero or reversed. With the design, as finally adopted, it is expected that zero excitation will give less than full load current on the generators with open circuit at the receiver end.

Construction of Transmission Line

One transmission line will be built at present. It will have a total length between Caribou power house and Valona substation of 185.1 miles. The conductor and towers are of two types. For fifty miles at the power house end, where the elevation ranges from 4,000 feet down to 300 feet, the conductor is aluminum steel .861 inches in diameter, and the towers are designed with conductors disposed in a horizontal plane 22 feet on centers. For the remaining distance, the conductors are aluminum steel .741 inches in diameter, and the towers are designed with the conductors disposed in a triangular form having an average spacing of 18.8 feet. The insulators used will be of the disc type and will have ten discs in series for suspension, and 12 discs in series, 2 sets in parallel, for dead ends.

A new device in transmission line construction is to be used on this line. It consists of a cast iron disc 12 inches in diameter, ⅛ inch thick, with a rolled edge 1 inch in diameter. These discs will be placed between the wire and the insulator nearest thereto. Most remarkable results have been shown in the laboratory tests regarding the potential gradient of the insulators equipped with this device, which is the invention of Mr. Koontz, electrical engineer of the Great Western Power Company.

At a point near the Big Bend power house, compensators will be installed to connect the existing 100,000-volt system to the new 165,000-volt system. These compensators will be Y connected, permanently grounded and provided with a tertiary winding connected in closed delta for suppression of the third harmonic currents. This method of connection between the two systems will furnish a definite ground for the neutral of the present 100,000-volt delta delta connected system. At Valona substation two 22,500-kva. banks of compensators will be provided, Y connected and permanently grounded. These compensators will also be provided with closed delta connected tertiary windings to which will be connected two 15,000-kva., 11,000-volt synchronous condensers. The ultimate development of Caribou will require six 22,500-kva. banks of compensators and six 15,000 kva. synchronous condensers at Valona. The present difficulty of obtaining materials in a reasonable time will make necessary a temporary connection between the Caribou development and Big Bend. For this purpose, advantage will be taken of the 120,000-volt tap which has ben provided in the Caribou transformers and direct connection will be made at Big Bend power house to the existing delta delta system; a similar connection will also be made at Valona, pending receipt of the necessary compensators and synchronous condensers for connection at Big Bend and Valona.

The following figures apply to the electrical characteristics of the line and for purposes of comparison are given with and without the use of synchronous condensers:

COMPARISON WITH AND WITHOUT CONDENSERS
ZERO LOAD RECEIVED

Without Condenser		With Condenser
150,000	Receiver Volts	150,000
133,750	Generator Volts	165,000
18,800	Generator Kva.	2,100
390	Generator Kw.	776
2.04% Lead	Generator P. F.	40.1% Lead
-10.2%	Line Volts drop in per cent of Gen. Volts	9.09%
	Condenser Kva.	21,700 Lagging

54,000 KW. RECEIVED

Without Condenser		With Condenser
150,000	Receiver Volts	150,000
220,800	Generator Volts	165,000
75,400	Generator Kva.	60,850
63,000	Generator Kw.	60,800
83.5% Lag	Generator P. F.	99.99% Lead
85.6%	Efficiency of Transmission	88.7%
65%	Voltage Variation Gen. End	0
62.2%	Reg. Receiver End with Loss of Load and Condensers	21.2%
81.9%	Reg. Line and Trans. with Loss of Load and Condensers	19.3%
243,300	Max. Voltage (Receiver End)	182,000
250,000	Minimum Insulation Required	190,000

British Columbia Interconnections

BY J. LIGHTBODY

(The progress and well-being of the electric utilities in British Columbia is of utmost importance to their neighbors on the south, and increasingly so as interconnection becomes more important. The following account of a development characteristic of electrical progress in the West is by a member of the British Columbia Electric Railway Company.—The Editor.)

While California and Oregon will soon be linked together with a continuous circuit of copper north and south, central stations farther north have not been idle. Already the link exists over the Canadian border into British Columbia, connecting up central stations in the vicinity of Vancouver, B. C., with their neighbors immediately south in Washington.

Twenty miles north of the 49th parallel lies Vancouver, together with the adjacent municipalities making up Greater Vancouver, the cities of North Vancouver and New Westminster and the towns of Steveston, Port Moody, White Rock, Cleverdale, Abbotsford and Chilliwack on the Canadian side, and Blaine, Washington, are supplied by the British Columbia Electric Railway Company with electric light and power service and some of them with electric railway service. These lines comprise the mainland system which is distinct from the Vancouver Island system of the British Columbia Electric Railway Company centering at Victoria, B. C.

Plant No. 1 on the Lake Buntzen development of the British Columbia Railway Company. This and one other plant on the same lake have a combined capacity of 47,700 kw.

The company's two power plants at Lake Buntzen, sixteen miles from Vancouver, have a capacity of 47,700 kw. and its system is connected at its receiving station at Horne-Payne with the Western Power Company of Canada from which it takes power. The latter company in turn is connected with the Bellingham, Washington, system of the Puget Sound Power and Light Company, and if the gap of some 30 miles between the Bellingham and Seattle were filled, the high tension circuits extending south would be continuous into British Columbia.

The development at Lake Buntzen includes storage, the water being stored first in Lake Coquitlam and then in Lake Buntzen which it feeds, before operating the Pelton wheels under a head of 400 feet. The rainfall on these lakes has averaged more than 150 inches a year for a number of years. Lake Coquitlam, where the major portion of the water is stored, was enlarged by a 90-foot dam of rock and it is connected with the lower lake by a tunnel 2¼ miles in length.

The British Columbia Electric Railway Company has $43,000,000 invested in its public utilities in British Columbia. Besides its light and power systems, it operates street cars in Vancouver, North Vancouver and New Westminster on the mainland and in Victoria on Vancouver Island. It has 156 miles of interurban line on the mainland, connecting Vancouver, New Westminster, Steveston and Chilliwack, the line to Chilliwack being 76 miles long. It has an interurban line of 22 miles on Vancouver Island, the total mileage of railway being 367. In addition to these properties, it operates the gas companies in Vancouver and Victoria, under the names of the Vancouver and Victoria Gas Companies respectively.

This company was formed in 1893 to take over the companies then operating in the territory, and subsequently it took over others. The capital has been provided practically entirely by English investors, who are represented by a board of directors in London, while the management is in the hands of a general manager at Vancouver.

The territory covered on the mainland measures about 80 miles long and 25 miles broad, in which there are 14 substations. Except around Vancouver, the territory is comparatively sparsely populated. Up to 1913 the country expanded at a rapid rate, and since the war this is again the case. Consequently the company has been called on at times for rapid expansion of its facilities. The total energy generated rose from 50,000,000 kw-hr. in 1910 to 152,918,529 kw-hr. in 1919. The maximum 10-minute peak which occurred at 4:45 p.m. on November 27, 1919, was 43,800 kilowatts, while the maximum hourly output for 1919 was 41,000 kw-hr. The average load factor on the system is 40 per cent.

The company's territory follows mostly the interurban lines and in fact, the company has been the cause of the development of the entire district. It has 45,600 lighting customers and 2,300 power customers on the mainland. In the city of Vancouver it has the entire domestic service, the Western Power Company supplying some of the industrial

demand. In North Vancouver it has the whole field. In the city of New Westminster, power is bought by the city en bloc from the company and distributed to lighting customers by the city's own distribution lines. The company retains the power business. The other districts are mostly rural, including several towns of 500 to 2,000 inhabitants. The town of Blaine, Washington, also buys power en bloc and retails it to customers itself.

Vancouver not having the number of war industries of some cities, it was not affected to any extent by the cessation of hostilities. Two steel shipyards and a number of wooden shipyards were operating and continued to operate until recently, but they are expected to resume at an early date. The increase in other loads has more than made up for the drop in the power load these yards occasioned.

The largest industry around Vancouver, and for that matter in British Columbia, is lumbering. Lumbering is one of the chief industries along the Fraser Valley interurban line and a large number of the mills in the vicinity of Vancouver and New Westminster are on the company's freight lines. Electric power has a strong competitor in these lumber mills in which steam can be generated cheaply by using waste material, but in spite of this, electric power is used to some extent in every mill along the Fraser Valley between Vancouver and Chilliwack and in most other mills around Vancouver and New Westminster.

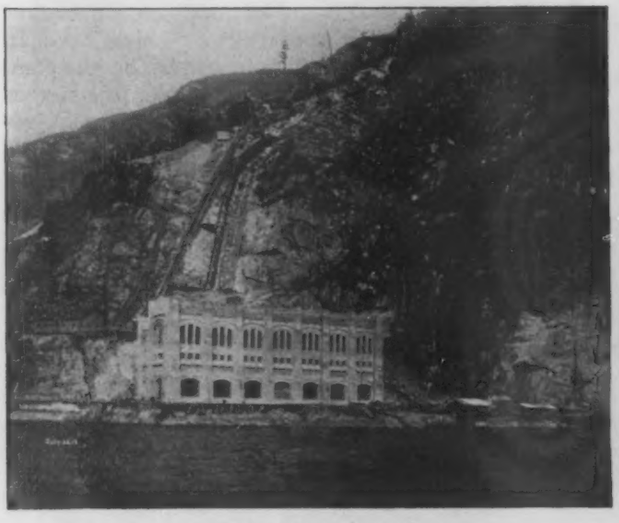
At Steveston, 14 miles from Vancouver, at the end of one of the interurban lines, there are a score of salmon canneries, practically all of which are supplied with electric power, but these are only a seasonal load and the big season comes only once in four years when the salmon run.

There are the usual evaporating plants, fruit canneries, milk factories, and so forth to be found in rural communities, connected with the company's lines along the Fraser Valley. Farms there are well supplied with power and light when at all within reach of existing pole lines.

The district adjacent to Vancouver is made up largely of the delta of the Fraser river. At certain seasons, during the time of high tides, it would be under water if an extensive dyking had not been done. To keep the land from being flooded during the rainy period, pumping is resorted to and this provides a good load. One such pump located near Ladner has a capacity of 20,000 gallons a minute, and there are numerous others of smaller size.

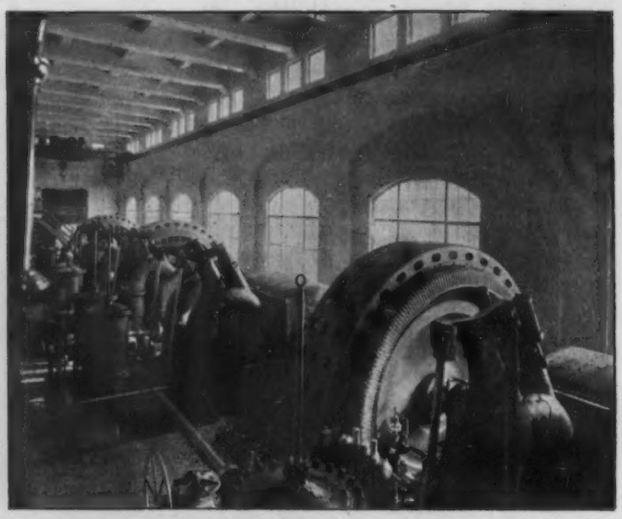
The load on the central stations in British Columbia is increasing very rapidly owing to new industries and the influx of settlers. Many thousands of Canadian soldiers from other provinces were discharged in British Columbia. These factors are causing the province to develop fast.

There is no shortage of power available for development at the present moment. A recent government survey placed the amount of power within a radius of 50 miles of Vancouver, including that developed, at 300,000 hp. British Columbia has several million horsepower in her streams, but much of it lies at distances of 100 to 150 miles from Vancouver and is separated from it by difficult country.



LAKE BUNTZEN PLANT No. 2

Plant No. 2 on the British Columbia Railway Company's development at Lake Buntzen. The rainfall on this lake has averaged more than 150 inches a year for a number of years.



GENERATOR ROOM — LAKE BUNTZEN PLANT

Generators at No. 2 Power House on Lake Buntzen. The company generated 152,918,529 kilowatt-hours in 1919. The average load factor on the system is 40 per cent.

NATIONAL RAINFALL

In a dry season such as this it is encouraging even to speculate upon the amount of water which falls yearly upon this country. It has been estimated that the average amount of water which descends as rain or snow in the United States is enough to fill Lake Ontario two times and leave something over for a third time; and further, four years of rainfall would probably be enough to fill all the Great Lakes. The rain descends from clouds which average half a mile in height, and in raising the water to this height before falling Nature must perform the work of lifting 3,166,000,000,000 tons one mile per year. This is equal to 1,920,000,000 continuous horsepower.

Electric Extensions in California

BY P. M. DOWNING

(The growing diversity of the load is one of the most outstanding features of the abnormal demand for power which has sprung up duringthe past few years. Power companies which have ordinarily looked upon lighting as their principal responsibility now find themselves called upon for great quantities of power for other purposes. The following account of some contemplated California extensions is by the vice-president in charge of electric operation with the Pacific Gas & Electric Company.—The Editor.)

During the recent world war but few if any of the power companies of the country were able to increase their generating plant facilities to keep pace with the demand for power. The power requirements of essential war industries created such an abnormal demand for service that the small margins of reserve plant capacity ordinarily maintained were very soon wiped out. Unsettled financial and labor conditions made it impossible to undertake any new work, except such as was absolutely necessary to meet the ever increasing demands for power.

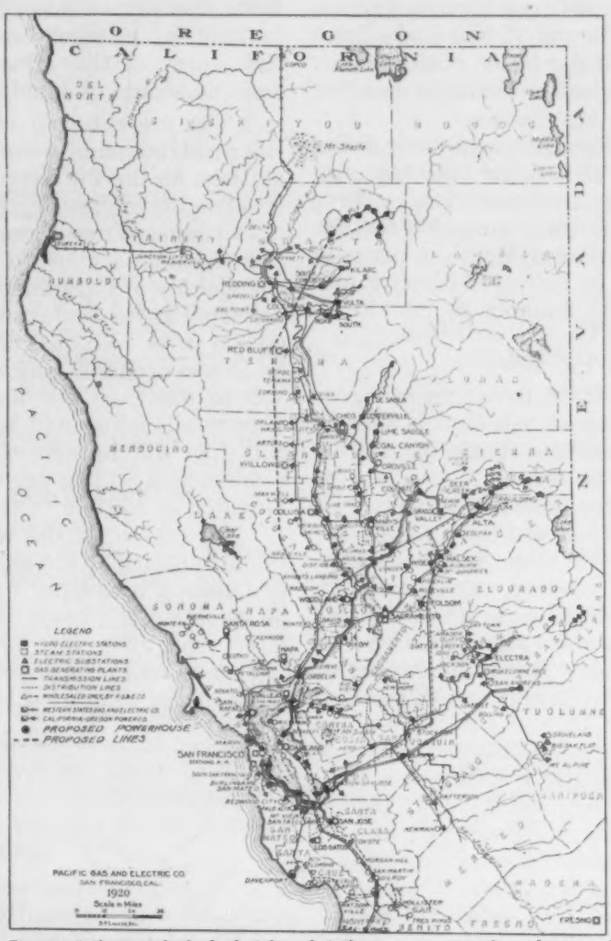
Rice Irrigation Load

Along with the usual requirements of the various war industries were those of allied industries having to do with the production of foodstuffs. In the north central part of California the industry falling within the latter classification that has created the greatest demand for power is rice irrigation. Between 1912 and 1919 the acreage planted to rice increased from practically nothing to 166,826, thus creating for this one industry alone a demand of approximately 17,500 hp.

Rice irrigation pumping is a seasonal load extending, approximately, from April 15th to Sept. 15th. Unfortunately, the latter half of this pumping period occurs at a time when the natural flow of the streams supplying the hydroelectric plants is at a minimum and has to be supplemented by stored water. During the past three years the situation has been particularly aggravated by reason of the unusually low precipitation. In addition to the stream flow shortage the water plane has lowered, thus increasing the distance the water has to be lifted.

A graphic illustration of the actual and estimated increase of the load of Pacific Gas & Electric Company from 1910 to 1028 is shown on the accompanying chart entitled: "Estimated and Actual Peak and Average Loads — Pacific Gas & Electric Co." From this it will be seen the kw-hr. deliveries into the system increased during that period frim 509,-250,334 in 1910 to 994,557,418 in 1919. During the same time the peak increased from 96,202 in 1910 to 187,135 in 1919.

The fact that during this period the increase has been at practically a uniform rate gives an excellent basis on which to estimate the probable increase that may be expected during the next few years. Following the projection of this load curve indicates that we may reasonably expect an annual increase in energy output of 75 to 100,-000,000 kw-hr. which, at the prevailing load factor, will require 15 to 20,000 kw. of installed capacity to supply.



Power stations, principal electric substations, gas generating plants and electric transmission and distributing system of the Pacific Gas & Electric Company.

Construction Plans

To meet this increasing demand for power the Pacific Gas & Electric Company has outlined a comprehensive construction program extending over a period of years, which includes extensive developments of both generating and transmission facilities.

To meet the urgent demand that may reasonably be expected during the coming irrigation season by reason of the subnormal precipitation of the last three years, a 12,500-kw. steam turbine with the necessary boilers, auxiliaries, etc. will be installed in Oakland. Shipment on this has been promised for July 1, 1920, thus allowing ample time for its installation before the most critical period of the short water season this fall.

At the Stanislaus plant on the Sierra system a third pipe line is being installed. This will increase the peak load capacity of the plant from 34,000 kw. to 40,000 kw. The original rating of the generators in this plant was 6700 kw. each. They have since

been rebuilt and, equipped as they now are with forced ventilation, they have a re-rated capacity of 10,000 kw. each. On the basis of the new rating, the peak load that can be carried on the plant has been limited by the pipe lines. With increased pipe line capacity and its present ample forebay storage this plant will become a very important factor in handling peak loads.

The diversion of water for the Stanislaus plant is made at Sand Bar on the Middle Fork of the Stanislaus river. In common with other streams having their origin in the southern Sierras, this stream has a large seasonal variation. The minimum flow is supplemented by water supplied from storage reservoirs, the most important of which are Relief, located on Relief Creek, a tributary of the Middle Fork, and Strawberry, located on the South Fork of the Stanislaus. The water from Strawberry is carried across the divide between the South and Middle Forks down the side of the canyon into the latter stream a few miles above Sand Bar, under an available head of 2335 feet.

It is proposed to utilize this head now being wasted by the installation of a single 9000-kw. generator driven by a 12,500-hp. impulse wheel. Three transformers will step the voltage up to 104,000 for transmission to Stanislaus Power House, a distance of 21 miles, where it will be delivered directly into the main transmission lines running to San Francisco.

Power from Pit River

By far the most important development under consideration by the company at this time is that on Pit river. It is a significant fact that Pit river is the only stream flowing into the central valleys of California having its principal source of supply east of the Sierras. Rising near Goose Lake in the extreme northeast corner of the state, it flows southwest across a great plateau region, thence through the Sierras approximately 40 miles southeast of Mt. Shasta, finally flowing into the Sacramento river a short distance above Redding. The drainage area of this stream, above the point where it breaks through the mountains, embraces approximately 4355 square miles, greatly exceeding that of any other Sierra stream above its point of descent into the valley. Its watershed is peculiar in that it is composed very largely of porous lava overlying a more impervious basalt or sandstone. The lava absorbs water very readily thus affording an underground storage that gives a uniformity of flow unequalled by any other Sierra stream. This uniformity of flow, together with the fact that the normal minimum amounting to approximately 2500 cubic feet per second can be utilized under an aggregate head of approximately 2000 ft., within a distance of 30 miles, makes Pit River one of the best and most reliable sources of hydroelectric energy in the West.

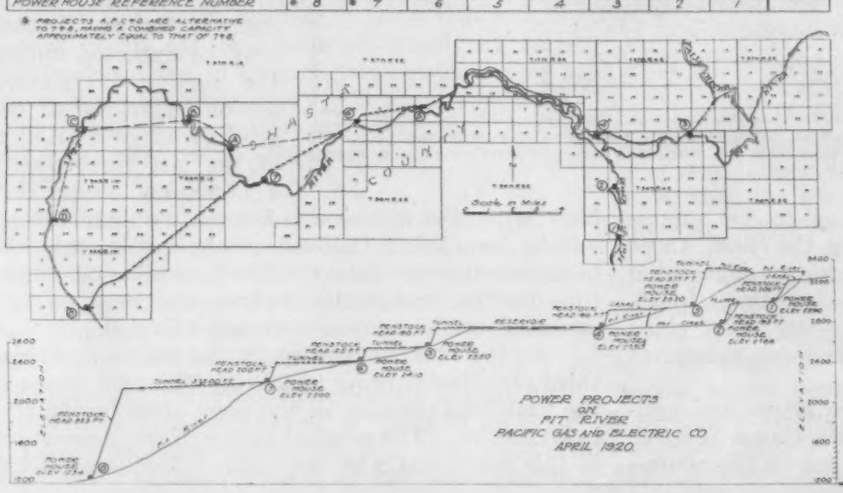
The power possibilities of the Pit River have long been known, but it is only within recent years since the art of transmitting electrical energy at present day voltages became known, that the potential energy of this stream could be considered as a possible source of supply for the Bay Cities.

The present plan of development contemplates the construction of a number of different generating stations on the Pit River and its tributaries and the construction of two or more main trunk transmission lines running from these plants to a main step-down transforming station to be located at some point in the vicinity of Carquinez Strait. Here energy will be delivered in to the existing system at 110,000 and 60,000 volts. No final decision has yet been reached as to the order in which these various installations will be made, or the ultimate voltage at which the transmission line will be operated. The length of this line will be approximately 220 miles and the construction will be such as will permit of its being operated at 250,000 volts.

By reason of the necessity of providing additional capacity at the earliest possible date, the first installation consisting of two 12500 kva. units will be complete and ready to put into operation by not later than June 1st, 1921. To complete the first transmission line will require two years. Until the main line is completed the output of this plant will

AVERAGE LOW WATER FLOW-CU FT PER SEC.	2500	2500	2500	2500	1500	1400	600	400	TOTAL
AVAILABLE NET HEAD IN FEET	923	200	125	190	160	375	195	206	
AVAILABLE K.W AT AVG LOW WATER & 80% PLANT EFF	156,900	34,000	21,200	32,300	16,300	35,700	8,000	5600	310,000.
K.V.A TO BE INSTALLED	200,000	50,000	30,000	50,000	25,000	50,000	12,500	12,500	430,000
POWER HOUSE REFERENCE NUMBER	* 8	* 7	6	5	4	3	2	1	

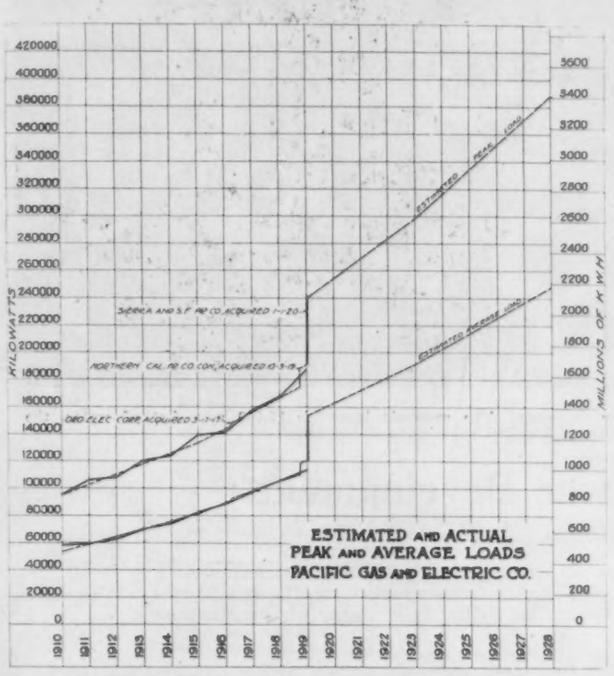
* PROJECTS A, B, C & D ARE ALTERNATIVE TO 7 & 8, HAVING A COMBINED CAPACITY APPROXIMATELY EQUAL TO THAT OF 7 & 8.



The Pit river plan includes a number of generating stations and two or more main trunk transmission lines running to a main step-down transforming station. Here energy will be delivered into the existing system at 110,000 and 60,000 volts. The length of the line will be approximately 220 miles.

be delivered temporarily into the existing system at 60,000 volts.

With the completion of the main trunk transmission line and additional generating capacity that will permit of the delivery of energy in excess of that to be had from the first installation, it will be


KILOWATTS
MILLIONS OF K.W.H.
ESTIMATED AND ACTUAL
PEAK AND AVERAGE LOADS
PACIFIC GAS AND ELECTRIC CO.
ESTIMATED PEAK LOAD
ESTIMATED AVERAGE LOAD
SIERRA AND S.F. RR. CO. ACQUIRED 1-1-20
NORTHERN CAL. RR. CO. CON. ACQUIRED 6-1-19
GEO. ELEC. CORP. ACQUIRED 3-1-17

Deliveries into the system increased from 509,250,334 kw-hr. in 1910 to 994,557,418 kw-hr. in 1919. These figures give a basis on which to estimate the probable increase to be expected during the next few years.

necessary to construct additional 110,000 volt lines from the main transforming station, to be located at or near Carquinez Strait, into Oakland to connect with the 110,000 volt line now under construction between that place and Newark. This will complete a 110,000-volt ring bus consisting of 334 miles of steel tower line, extending from Drum Power House, through to Cordelia, thence across Carquinez Strait to Oakland and on to Newark where it will connect with another line running from Drum via Halsey and Wise Power Houses to Newark substation. At the latter place the 110,000 volt lines of the Sierra and San Francisco system will be connected to this bus. The new trunk line from Pit River will also deliver energy directly into this bus at the proposed new substation near Carquinez.

Additional Transmission Facilities

Another important addition to the Company's transmission facilities now under construction is a second circuit consisting of 161.5 miles of 3/0 copper on the Drum-Wise-Newark 110,000 volt line. This circuit will give increased capacity from the plants in Yuba and Placer counties to Newark and the Southern end of the system, thus relieving the lines entering the bay districts via Cordelia and Carquinez and making them available for the additional power that will be brought in from the north.

A 60 kva. line is being constructed from Modesto to Newman, a distance of 35 miles. The San Joaquin Light and Power Corporation is also constructing a line to this place. When these two lines are completed the system of Pacific Gas and Electric Co. and the San Joaquin Light and Power Corp. will be tied together, thus completing an interconnected network of lines from Southern Oregon on the north and the Mexican border on the south.

From the accompanying load curve it will be seen that a conservative estimate of the annual increase in peak load is 15,000 to 20,000 kw. Under present day prices of labor and material hydroelectric installations, including generating plants, transmission lines and step-down transforming stations will cost approximately $200 per kw. On this basis it will be seen that neglecting any consideration of investment in distribution facilities for marketing this energy, the capital expenditures necessary to produce and deliver this amount of power to the distribution centers alone amounts to between $3,000,000 and $4,000,000 per year.

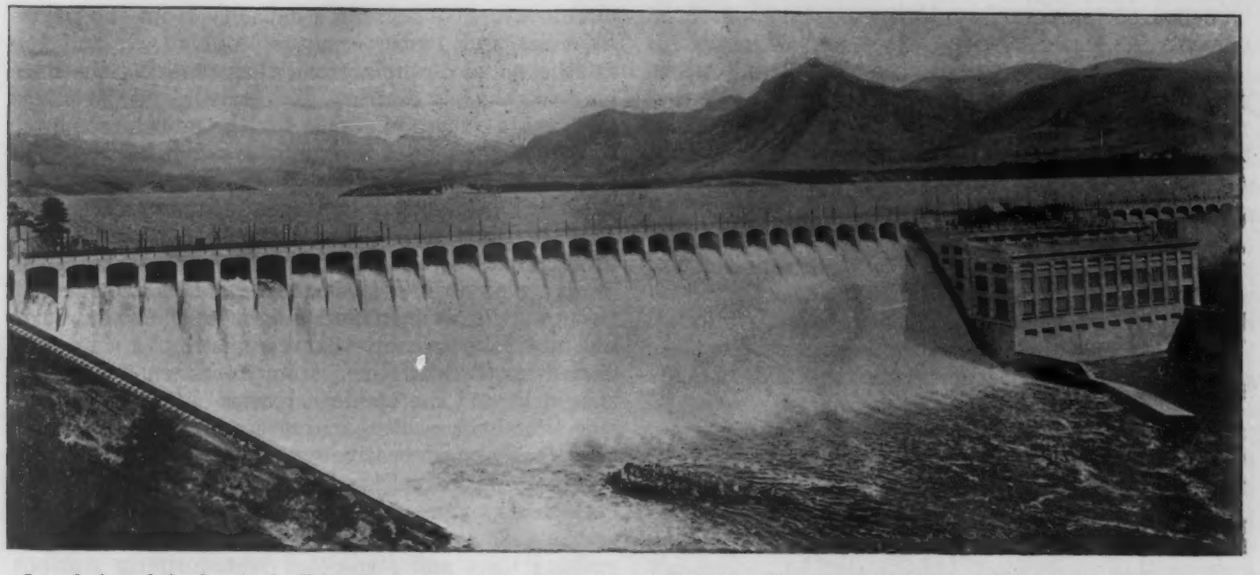
SYSTEM PEAK AND AVERAGE LOADS, LOAD FACTORS, AND PER CENT INCREASE

Year	Peak Kw.	% Increase over previous year	Average Kw.	% Increase over previous year	Load Factor	% Increase over previous year
1910	96,202	-4.3	58,746	.4	.612	4.9
1911	106,102	9.3	60,832	3.5	.573	-6.4
1912	108,149	1.9	63,816	4.7	.591	3.0
1913	119,771	9.9	70,851	9.3	.59	-.2
1914	124,040	3.4	75,175	5.8	.606	2.7
1915	139,540	12.5	82,844	10.2	.594	-2.0
1916	141,008	1.04	87,466	5.1	.62	4.0
1917	158,272	12.2	97,500	11.5	.616	-.7
1918	166,705	5.3	105,256	7.9	.631	2.4
1919	187,135	12.2	113,533	7.86	.607	-.38

SAVING ON REPAIR PARTS FOR CONSTRUCTION WORK

The Kerckhoff project now being constructed on the San Joaquin river by the San Joaquin Light & Power Corporation under the engineering direction of R. C. Starr, involves the driving of a 17-ft. by 17-ft. pressure tunnel through solid granite. This sets a record for tunnel dimensions in hydroelectric work. Not only does this provide a greater capacity, but it has been found that through the fact that it is possible to use a steam shovel in excavation work and do away with the laborious and unreliable mucking machines, labor costs are greatly reduced and it is possible to make much greater progress in a day. At the present time an average of 12 ft. a day on each face worked is maintained.

In connection with the use of the steam shovel, it was of course found necessary to have on hand all the repair parts which might be needed, so that work should not be unduly interrupted. To provide a complete set of parts costs about the same as a new shovel complete,—in the neighborhood of $14,000. It has been found economical to purchase instead a second-hand shovel, which can be obtained at a cost of some $6,000. As parts are needed, they are borrowed from this machine. It is planned to replace the few missing parts at the end of the construction work and to sell the machine again at second-hand. The initial saving is of course, very large, and with the rising costs of all machinery it may be possible at a later date to further reduce the expense by selling the machine at more than was paid for it or at least at a price sufficient to cover the major part of the expense.



General view of the dam at the Holter development of the Montana Power Company. The reservoir impounds 89,000 acre feet of water, the plant operating under a head of 107 ft., with an installed capacity of 40,000 kw.

Montana Water Power Development

BY J. H. BONNER

(The West is exceptionally favored in the matter of water power, and the fact that it is a pioneer in the electrification of mines and railways is due in large measure to extensive hydroelectric developments such as those described below. The author is engineer of the Montana Public Utility Commission.—The Editor.)

A true account of the great development of hydroelectric power in Montana is surprising to one who is not familiar with the actual facts. By electricity, generated from flowing water, monster freight and passenger trains are driven over 530 miles of track, across three mountain ranges; the great mines and smelters of the state, with their tremendous output, are operated; over fifty towns and cities are supplied with light, heat and power; water is raised into irrigation ditches that supply thousands of acres of land; dozens of mills, street and interurban railways, cement factories and dredges are supplied with power.

The Montana Power Company, the largest power company in the state, has at the present time thirteen hydroelectric plants, scattered over the state with a total installation of nearly a quarter of a million kilowatts; 1922 miles of high tension transmission lines, connecting 75 sub-stations; and over 500 men employed in their operation. It has undeveloped sites that will supply 100,000 kw. more when the need arises. By great dams it has controlled the flow of rivers and so harnessed them as to bring electrical power within the reach of thousands, for economic and convenient use.

Natural Advantages of Montana

Montana is one of the leading states in hydroelectric development. Nature was indeed lavish to the state in this regard. Two of the greatest rivers of the continent, the Missouri and the Columbia, have their source in the high mountains of Montana, and after traversing the state for great distances leave its borders at comparatively low elevations. While these mighty rivers are considerable streams at elevations from 5,000 to 7,000 feet above sea level, both of them leave Montana at about 2,000 feet elevation, having a fall within the state of from 3,000 to 5,000 feet. These great rivers are fed by innumerable mountain streams, which with their cascades and cataracts offer an almost illimitable opportunity for the cheap development of power. Conservative electrical experts have estimated that by the harnessing of merely the larger streams of the state more than 1,000,000 horsepower can be made available for the use of the growing industries.

The main range of the Rocky Mountains divides Montana into two parts: the eastern section drained by the Missouri river and its tributaries; the western part drained by the tributaries of the Columbia, the Clark's Fork and the Kootenai rivers. An important tributary of the Clark's Fork river is the Flathead river, which drains Flathead lake. Upon all of these streams there are either large power plants or power sites waiting development.

Transcontinental Electric Railroads

Montana was one of the pioneers in electrical development. Here was built one of the first long-distance, high-tension transmission lines in the world carrying 50,000 volts, and here electrical energy was first utilized for the handling of heavily loaded transcontinental freight trains.

The Butte, Anaconda & Pacific Railway, running from Butte to Anaconda, with 90 miles of electrified track, and carrying in addition to passenger business, heavy ore trains between the Butte mines and the Anaconda smelter, was the first successful at-

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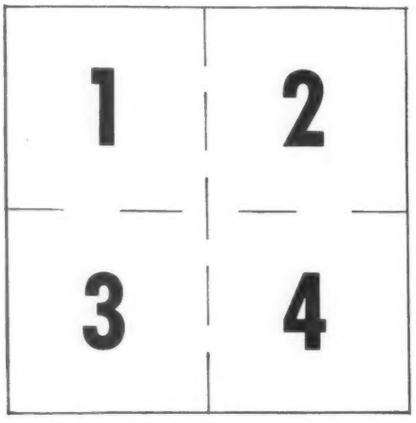

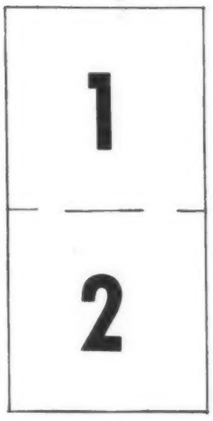

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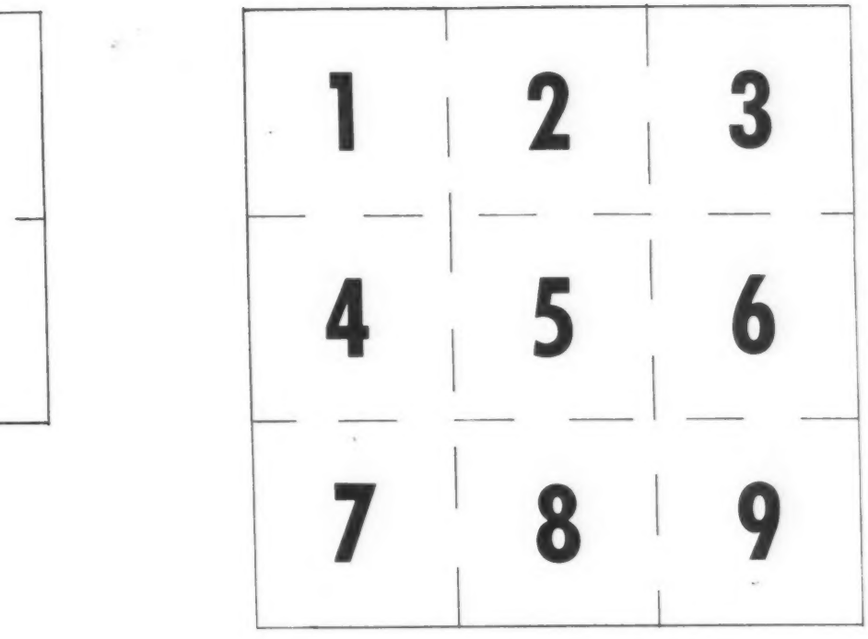

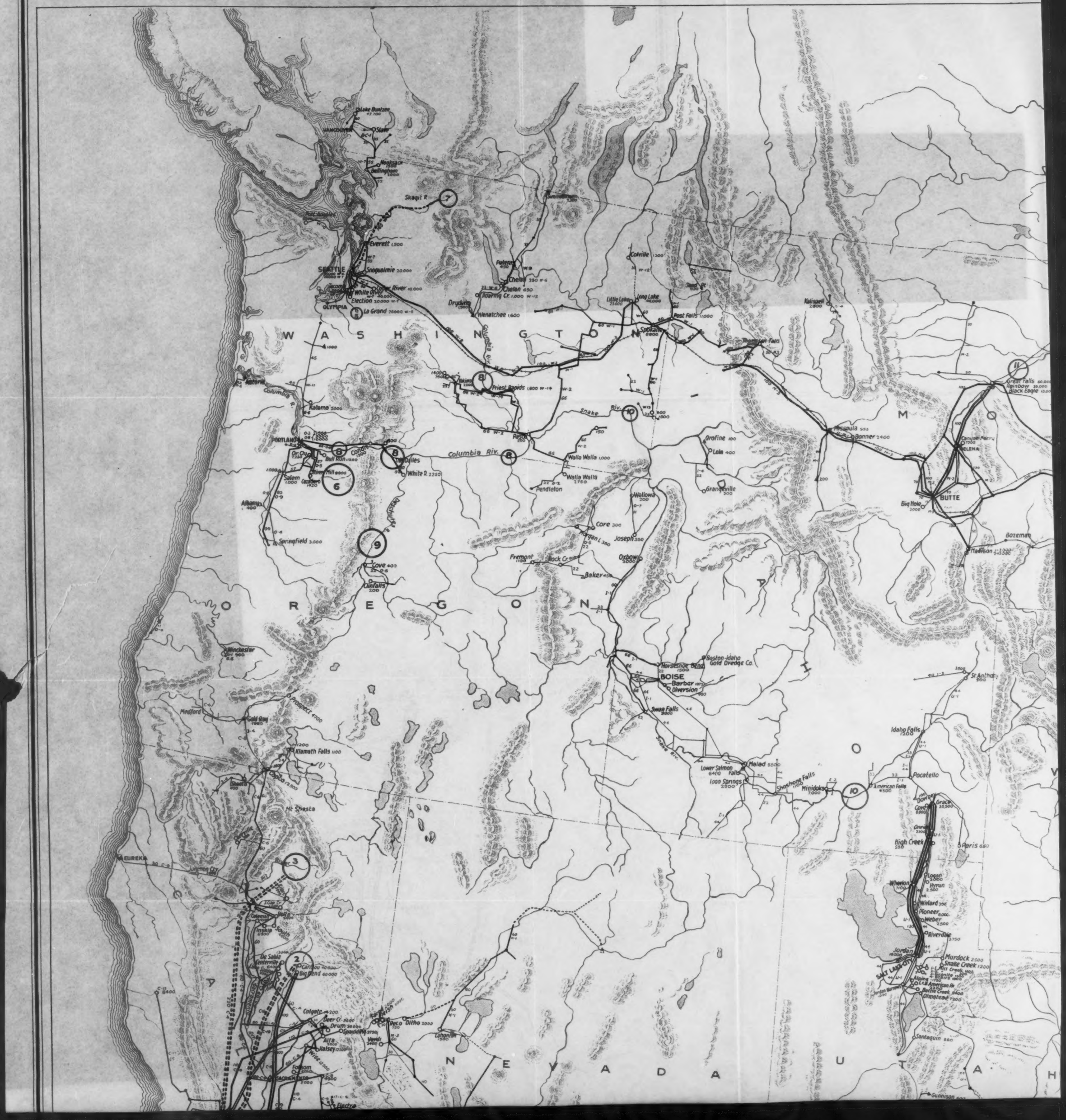
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Everett 1,500
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Tacoma
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White River 26,000
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Salem 1,000
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Grofine 100
Lolo 400
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Morgan L 300
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Minidoka 7000
Idaho Falls 1200
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Hyrum 2,500
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Winlard 300
Pioneer 6,000
Weber 2,500
Riverdale 3750
Jordan 18000
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Mill Creek 1100
Bonneville 1500
Alpine 1750
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Bertie Creek 2400
Olmstead 1200
Santaquin 880
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Trinity Reservoir
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Lake Sonoma
Lake Pillsbury
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Chelan 650
Chelan 250
Peterson
Wenatchee 1,600
Priest Rapids 1,600
Yakima
Roosvlt Cr. 1,000
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La Grand 28000
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Election 20,000
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Cedar River 10,000
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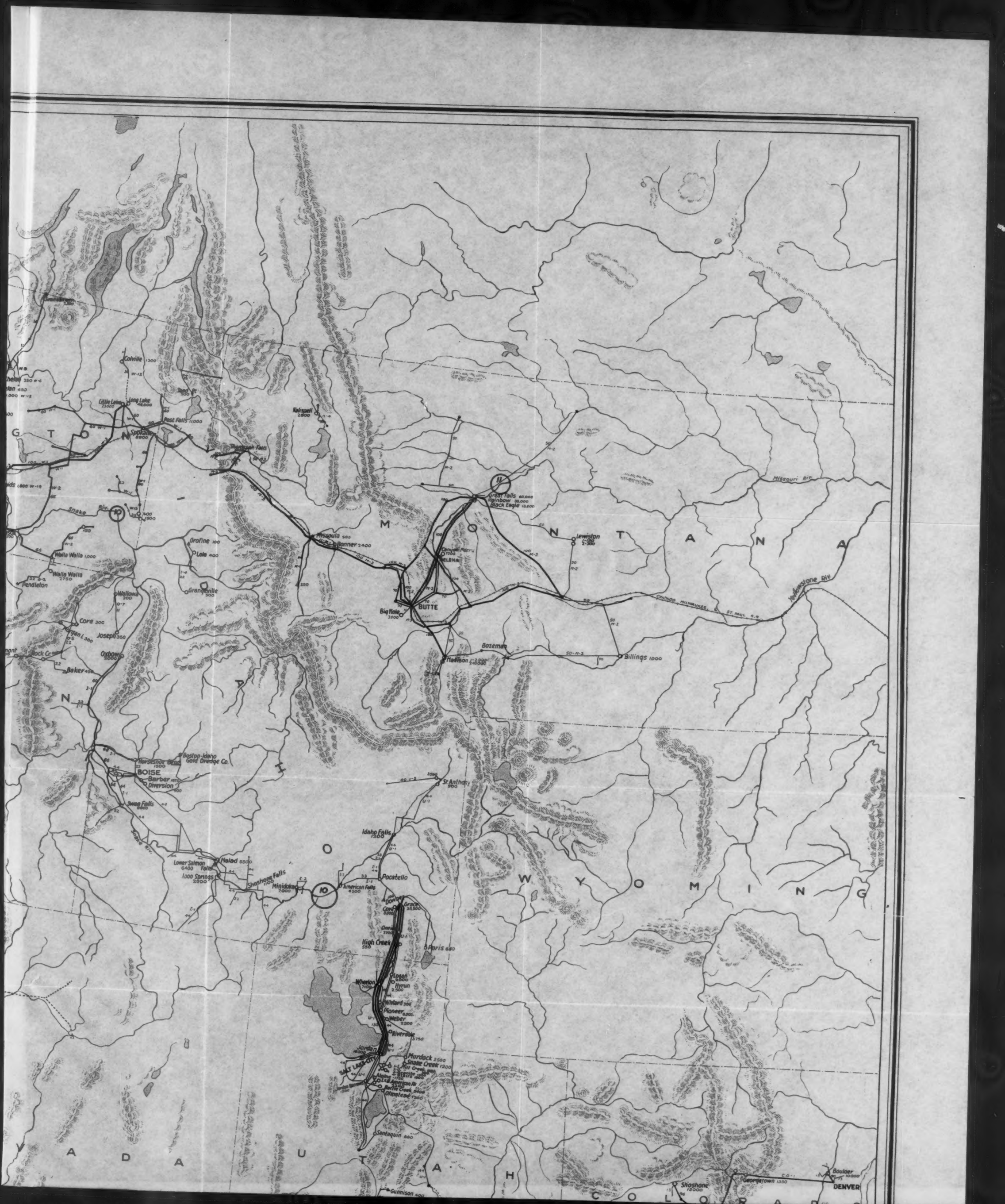
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Grangeville 500
Orofino 100
Lolo 400
Missoula 500
Bonner 2400
Great Falls 60,000
Rainbow 39,000
Black Eagle 13,000
Missouri Riv.
Lewiston 1300
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Big Hole 3000
Yellowstone Riv.
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Core 300
Joseph 350
Oxbow 2000
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Battle Creek 5400
Orchard 1200
Santaquin 850
Shoshone 15000
Georgetown 1350
Boulder 10000
DENVER
IDAHO
WYOMING
UTAH
COLORADO

Medford
Prospect
Gold Ray
Klamath Falls
Mt. Shasta
EUREKA
Junction City
Willits
Ukiah
Colgate
Beer Cr.
Drum
Spaulding
Alta
Halsey
Wise
Folsom
SACRAMENTO
Electra
Stanislaus
Phoenix
Knights Ferry
La Grange
Oakdale
Merced
Crane
Big Creek
Kerckhoff
Fresno
Visalia
Kaweah
Tule
Kern R.
Borel
Oil Fields
BAKERSFIELD
Santa Maria
Santa Barbara
San Francisquito
Azusa
Sierra Madre
Little Rose
Fontana
Santa Ana
Mill Creek
San Bernardino
LOS ANGELES
Redondo
Long Beach
San Diego
Jordan
Silver Lake
Owens Lake
Swan Falls
Lower Salmon Falls
Malad
Thousand Springs
Shoshone Falls
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Olmstead
Santaquin
Gunnison
Sevier
Beaver
KINGMAN
Jerome
Tapco
Prescott
Irving
Chilis
Falls
Roosevelt
Granite Reef
Cross Cut
PHOENIX
NEVADA
UTAH
ARIZONA

Western Hydroelectric Systems

SHOWING

Transmission Lines, Power Plants and Some Major Undeveloped Water Power Sites

As of May 15, 1920

UNDEVELOPED POWER SITES

Indicated as blue circles with numbers corresponding to the following key:

	Kilowatt Capacity		Kilowatt Capacity		Kilowatt Capacity
1. Big Creek	643,000	5. Tacoma	60 000	9. Deschutes River	400,000
2. Feather River	400,000	6. Clackamas River	100,000	10. Snake River	550,000
3. Pit River	400,000	7. Skagit River	180,000	11. Missouri River	200,000
4. Kings River	125,000	8. Columbia River	700,000	12. Colorado River	500,000

KEY TO COMPANIES

ARIZONA

A-1. Salt River Valley Water Users' Association.
A-2. Pacific Gas & Electric Co.
A-3. Arizona Power Co.
A-4. Desert Power & Water Co.
A-5. Bisbee Improvement Co.
A-6. Prescott Gas & Electric Co.

CALIFORNIA

C-1. Southern California Edison Co.
C-2. San Diego Consol. Gas & Elec. Co.
C-3. Southern Sierras Power Co.
C-4. Pacific Gas & Electric Co.
C-5. Los Angeles City.
C-6. California-Oregon Power Co.
C-7. Coast Valleys Gas & Electric Co.
C-8. San Joaquin Light & Power Co.
C-9. Western States Gas & Electric Co.
C-10. Great Western Power Co.
C-11. Snow Mountain Water & Power Co.
C-12. San Francisco City.

COLORADO

Co-1. Colorado Power Co.
Co-2. Colorado Springs Lt., Ht. & Pwr. Co.
Co-3. Arkansas Valley Ry., Light & Pwr. Co.
Co-4. Western Colorado Power Co.

IDAHO

I-1. Idaho Power Co.
I-2. Minidoka Project.
I-3. Ashton-St. Anthony Power Co.
I-4. Grangeville Electric Light & Power Co.

MONTANA

M-1. Missoula Light & Water Co.
M-2. Montana Power Co.
M-3. Chicago, Milwaukee & St. Paul Ry.

NEVADA

N-1. Nevada Valleys Power Co.
N-2. Nevada-California Power Co.
N-3. Sierra Pacific Electric Co.

OREGON

O-1. Douglas Co. Light & Water Co.
O-2. Pacific Power & Light Co.
O-3. Portland Ry. Light & Power Co.
O-4. Mountain States Power Co.
O-5. Eastern Oregon Light & Power Co.
O-6. Deschutes Power Co.
O-7. Enterprise Electric Co.
O-8. Northwestern Electric Co.
O-9. Oregon Electric Ry. Co.

UTAH

U-1. Utah Power Co.
U-2. Telluride Power Co.

WASHINGTON

W-1. Washington Water Power Co.
W-2. Pacific Power & Light Co.
W-3. Intermountain Power Co.
W-4. Seattle City.
W-5. Tacoma City.
W-6. Chelan Power Co.
W-7. Puget Sound Power & Light Co.
W-8. Chicago, Milwaukee & St. Paul Ry.
W-9. Wenatchee Valley Gas & Elec. Co
W-10. Northwestern Power & Mfg. Co.
W-11. North Coast Power Co.
W-12. Stevens Co. Light & Power Co.
W-13. Wash.-Idaho Water, Light & Power Co.
W-14. Black Rock Power Co.

BRITISH COLUMBIA

BC-1 British Columbia Electric Ry. Co.

Small black circles: Hydroelectric power plants. Kilowatt capacity of plants indicated by figures following names.
Small black triangles: Steam-electric stations. Kilowatt capacity of plants indicated by figures following names.
Small black dots in lines: Principal substations.

Transmission lines shown by lines of different widths:
widest lines for voltages above 100,000;
intermediate size for lines 60,000 volts to 100,000 volts;
narrowest lines for voltages less than 60,000.

Voltage of transmission lines indicated by figures near lines.
Voltages given in kilovolts.

Dotted lines are transmission lines under construction, or projected for near future.

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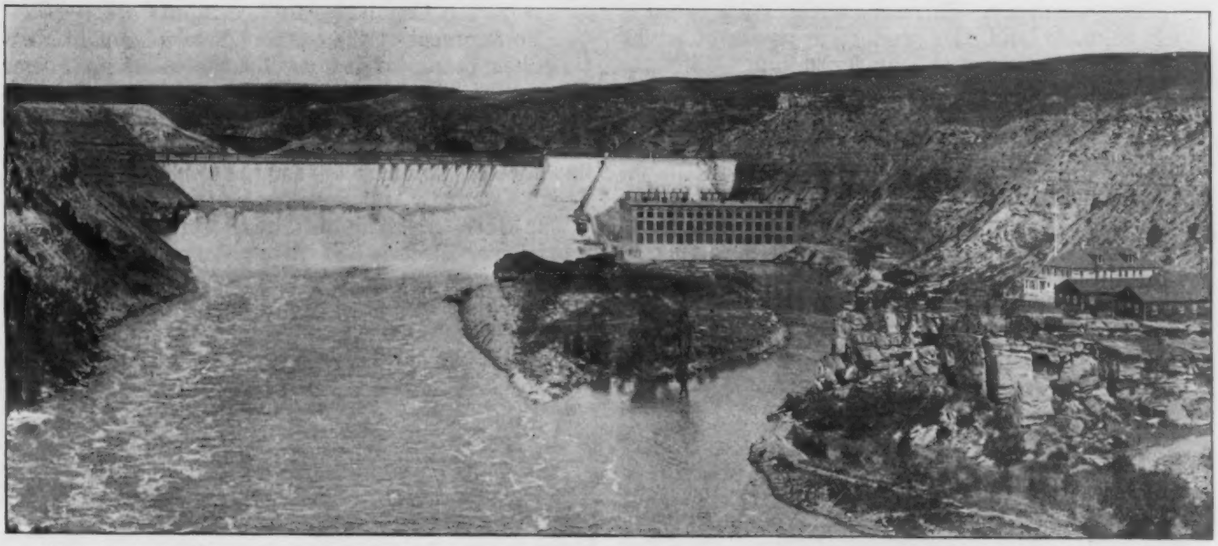


The dam and power house at Volta Station on the Montana Power Company's system. The installed capacity of the plant, which was completed in 1916, is 60,000 kw. The plant is located on the Missouri River at the Great Falls.

tempt to utilize electric power to replace steam locomotives for general railway traffic. The work of the Butte, Anaconda & Pacific was watched with interest by railway experts all over the world, and as soon as its success was demonstrated the Chicago, Milwaukee & St. Paul Railway let contracts for the electrification of its lines across the main ranges of the Rocky and Bitter Root mountains, a distance, from Harlow, Montana, to Avery, Idaho, of 440 miles. This work has been completed and the success of the undertaking has exceeded the expectations of its fondest promoters.

Cheap Power Over Mountains

It is apparent that it is a matter of but a very short time until all the transcontinental railways, especially in their mountain divisions, must turn to electric operation. In fact, it is a matter of common knowledge that other transcontinental systems are even now making provision for this inevitable change. Electrical operation not only has the advantage of making large savings in the expenses of operation by the elimination of fuel and the greatly reduced maintenance expense of electric locomotives as compared with steam locomotives, but also on account of the fact that with the increase in traffic, due to the rapid development of western and trans-Pacific business, the capacity of the whole line is limited by the tonnage which can be hauled over the steep mountain grade. Inasmuch as the electric locomotives used have a much greater continuous power capacity than any steam locomotives yet built, it follows that heavier trains can be handled over the steep grades at considerably increased speed and the tonnage hauled over the division increased accordingly, while to get a corresponding tonnage increase with steam operation would require double-tracking.

In addition to this, the electric locomotives will do away with the possibility of forest fires from locomotives in the mountains through which the trains pass.

Electrically Operated Mines and Smelters

The great copper and zinc mines of the Butte district and other metalliferous mines throughout the state are using electric power almost exclusively. A lessened cost of production has resulted, enabling many mines now to be operated at a profit which could not be worked with more expensive power.

In the application of electricity to extensive mining operations Montana has easily assumed first place, and the energy obtained from distant water powers is being conducted to remote localities, difficult of access, where it performs an infinite variety of work in a most economical and efficient manner. So satisfactory have been the results obtained that it has practically superseded steam power, and is now driving the enormous hoists, compressors, pumps, mills and other mechanical appliances used in the mining operations carried on at Butte and in the great smelters of the Anaconda Copper Mining Company at Anaconda and Great Falls, and that of the American Smelting and Refining Company at East Helena. The Anaconda Copper Mining Company is diversifying its business more and more, and is an ever increasing power consumer. In addition to the power required for copper mining and smelting it has recently become a large zinc producer, and about 35,000 kilowatts are used for producing zinc by the electrolytic process. The company has recently completed a rod and wire mill at Great Falls, and has installed electric furnaces for melting zinc and for the production of ferro manganese. This process will require 20,000 kilowatts.

The saving by the use of electrical power can be better comprehended when it is understood that the development of one horsepower by coal costs an average of about $125, while electrical power is furnished to the mines at from $35 to $50 per horsepower year.

Power for Irrigation

Lifting waters by their own power is practically what is being done in the use of electricity for

irrigation purposes. Throughout the state there is much valuable land, the productive power of which can be greatly increased by irrigation. With the use of cheap electrical power for pumping, it is possible to put much of this land under water during the growing season, and the electrically operated reclamation projects throughout the state are an unqualified success. The largest of the reclamation plants of this character is in the Prickly Pear Valley, a few miles from Helena. Two large pumping plants for irrigation have been installed in this valley by the Montana Reservoir & Irrigation Company, which

Interior of the Rainbow Power House. This plant was enlarged in 1916, and now has an installed capacity of 35,000 kw.

secures its power from the Montana Power Company's Hauser Lake plant on the Missouri river. The Hauser Lake Dam forms a large artificial lake, from which the water is pumped to thousands of acres of adjacent farm lands. In this project, water for irrigation purposes is furnished at an exceptionally low rate, the contract price paid by the farmers being $1.75 per acre foot.

The Montana legislature, called in extraordinary session during the summer of 1919, passed a law creating a Montana Irrigation Commission empowered to create irrigation districts. The drought of the last three summers has emphasized the need for irrigation in the state and many districts are now being organized. Intensive development under irrigation will build up a summer pumping load that was not thought possible a few years ago.

Electricity in Cities

Approximately one-third of the earnings of the Montana Power Company are derived from lighting, heating and small power in fifty cities and towns in Montana. In addition to this, flour mills, electric street and interurban railways, cement plants, dredges, coal mines and numerous other industries consume a large amount of electrical energy.

The domestic water supply of many of the larger cities is pumped by electric power. Cooking by electricity is becoming very popular. Electrically driven sewing and washing machines are in every day use, and many other devices which tend to lighten the duties of the housewife.

Companies in Operation

So far most of the greater development in Montana has been carried on by the Montana Power Company. There are many other companies operating in the state; a total of 124 cities and towns are supplied with electric service as reported to the Public Service Commission for 1919. The Montana Power Company was developed from a consolidation of the Butte Electric and Power Company, the Missouri River Electric and Power Company, the Great Falls Power Company and the Thompson Falls Power Company, although the two latter companies are separate corporate entities. The complete summary of the plants under this company is as follows:

COMPLETED HYDRO-ELECTRIC PLANTS

	Head (ft.)	Installed Capacity (Kw.)
Big Hole, on Big Hole River, completed 1898	65	3,000
Canyon Ferry, on Missouri River, completed 1898, enlarged 1901	40	7,500
Madison No. 1, on Madison River, completed 1901, remodeled 1907	55	2,000
Madison No. 2, on Madison River, completed 1906	110	10,000
Livingston, on Yellowstone River, completed 1906, enlarged 1908	...	1,500
Lewistown, on Spring Creek, completed 1906, remodeled 1913	...	450
Billings, on Yellowstone River, completed 1907	...	1,080
Rainbow, Rainbow Falls on Missouri River, completed 1910, enlarged 1916	112	35,000
Hauser Lake, on Missouri River, completed 1911, enlarged 1914	65	18,000
Black Eagle Falls, on Missouri River, reconstructed 1913	44	3,000
Thompson Falls, on Clark's Fork of Columbia River, completed 1916	50	30,000
Volta, on Missouri River at the Great Falls, completed 1916	150	60,000
Holter, on Missouri River, completed 1918	107	40,000
TOTAL		211,530

UNDEVELOPED SITES

	(Kw.)
Madison No. 3, on Madison River	20,000
Great Falls "C," on Missouri River, above Great Falls	28,500
Sheep Creek, on Missouri River, below Great Falls	28,500
Fish Creek, on Missoula River	13,500
Black Eagle, on Missouri River, reconstruction	10,000
TOTAL	100,500

STEAM PLANTS

	(Kw.)
Butte, completed 1907 (reserve)	5,000
Billings, completed 1906 (reserve)	560
Conrad, completed 1910 (electric soon to be extended)	110
Phoenix (Butte), completed 1895	250
TOTAL	5,920

Transmission Lines

The transmission system of the company interconnects all of its power developments, with the exception of the Thompson Falls, and covers an area extending 260 miles from east to west and 300 miles from north to south. The various lines are tied together through transformers and operated as one complete network, into which power is fed from each of the plants, and from which power is taken by numerous sub-stations, varying in size from the Great Falls Power Company's sub-station at Butte, having a capacity of 21,000 kilowatts, down to the lowest standard high-voltage sub-station of 250 kilowatts. Almost 2,000 miles of transmission line are in operation, a considerable portion of which is steel tower line.

	Miles
Steel tower lines, 110,000 volts	341
Pole lines, suspension insulator type, 110,000 volts	400
Pole lines, suspension insulator type, 50,000 to 100,000-v.	632
Pole lines, pin type, 11,000 to 60,000 volts	549
Total, 1922	

Storage Reservoirs

The ideal generating system must have an even flow of water to its turbines, but this cannot be obtained if the natural flow of the river is depended upon. The low water stage of the river limits the output that can be marketed continuously. For this reason reservoirs are provided at each of the plants and in addition the great Hebgen reservoir has been

built on the Madison river, to control the supply on both the Madison and Missouri rivers. Each second foot of water released from this reservoir is utilized through the chain of eight great plants along the Missouri and develops 40 kilowatts. A summary of the reservoirs follows:

	Area, acres	Acre feet
Hebgen reservoir, on Madison river	13,400	322,000
Madison reservoir, on Madison river	4,030	21,000
Canyon Ferry reservoir, on Missouri river	4,570	36,000
Hauser Lake reservoir, on Missouri river	5,470	54.000
Big Hole reservoir, on Big Hole river	210	1,650
Rainbow reservoir, on Missouri river	120	1,000
Great Falls, on Missouri river	450	5,500
Thompson Falls, on Clark's Fork river	500	5,500
Holter reservoir, on Missouri river	5,005	89,000
Total,		535,650

Operating Statistics
The Montana Power Company
Calendar Year 1919

Generating Capacity	211,530	kw.
Maximum Load	152,800	kw.
Average Load	98,858	kw.
Power Generated	863,960,624	kw-hr.
Power Purchased	2,037,928	kw-hr.
Load Factor	65%	
Sub-station Capacity	309,625	kw.
Sub-station Consumption	744,956,047	kw-hr.
Loss in Transmission	121,042,505	kw-hr.
Loss in Transmission	14%	
Connected Load of Consumers	315,909	kw.
Consumption by Consumers	720,681,439	kw-hr.
Loss in Trans., Transformation & Distr'b.	145,317,113	kw-hr.
Loss in Trans., Transformation & Distr'b.	17%	

Only a small portion of the available water power in Montana has been developed. In addition to the plants already built and in operation, there are a great number of large power sites and numberless smaller ones ready for development as soon as the demands for power increase and there is available capital for their construction. Although these possible developments are located in all parts of the state, the large possibilities exist in the northwest section of Montana, where the waters of the Flathead, the Kootenai river and other large streams will, when harnessed, furnish more than 500,000 horsepower. The power site at the mouth of the Flathead lake, which is one of the most feasible in the state, has been reserved by the Government in connection with the reclamation system covering a portion of what was formerly the Flathead Indian Reservation. A number of smaller power sites have also been reserved, while many others are under private ownership.

When the value of the coal is considered that is being saved each year by means of water power, and that during the next ten years this saving will, in all probability, be increased seven or eight times, it is not difficult to understand that true conservation consists in encouraging the rapid development of water power, which unless developed and utilized becomes lost for all time.

Water Power in the "Inland Empire"

(The great water powers of the Pacific Northwest constitute one of the principal factors in the rapid growth of that district. The following account of some of the large installations gives a good idea of the type of hydroelectric development which is forwarding the industrial activities of the region.—The Editor.)

The Inland Empire—that section of the Pacific Northwest lying within a 150-mile circle of Spokane—is said to possess one-sixth of the nation's water power, the estimated total running into millions of horsepower.

Hydroelectric Plants

Electrical development in the Spokane district has centered about the unusual conditions existent in the Spokane river which in its 100 miles of turbulent career between Lake Coeur d'Alene and the Columbia river falls 1280 feet with a maximum flow of 40,000 second feet and a natural minimum of 1500 second feet. The lake constitutes a natural reservoir of 45 square miles in which six feet of water is conserved against low water period by dams at Post Falls and elsewhere above Spokane.

The demands upon the power furnished by the Spokane river are varied: The miner in the silver-lead and copper mines of the famous Coeur d'Alenes—which product one-third of the lead output of the United States—finds electricity economical in his work, and the treasure cities of the district, Wallace, Burke and Mace, are served by 60,000-volt lines running out of Spokane.

The Western farmer is alive to the value of water power and electricity supplies the many needs of the great wheat and apple sections to the south and west of Spokane. To the north and east, communities use the power for light and heat, and the lumber camps for power. In Spokane, industries and the street and interurban electric lines have been fostered by low-priced current and efficient service.

The Washington Water Power Company now has four hydroelectric plants: Post Falls, Little Falls, the Monroe Street city plant, and the recently completed Long Lake development, which boasts the highest spillway dam in the world, with 90,000 sec. ft. capacity. The Post Street sub-station is the distributing center for the power used in the city of Spokane, for lighting, heating and street and suburban railway lines.

The Spokane and Eastern Railway and Power Company has a 16,000-hp. capacity plant at Nine Mile on the river.

At the Washington Water Power Company's Post Falls plant east of Spokane, the river divides into three channels and in the middle channel is located the head gate dam and power house with five units installed at the present time, each unit consisting of a horizontal Francis central discharge, double-runner water wheel, operating under a head of 50 ft. The station has five outgoing lines, four of which are 60,000-volt and one 2300.

At the lower falls, in the heart of the city, is located the original hydroelectric station of the company. It operates under a head of 74 ft. and pro-

duces 8,800 hp. Two of the units consist of Francis turbines direct-connected to 2250-kw. a.c. generators, and the rest of the units are composed of water wheels and d.c. generators of various sizes ranging from 200 to 1200 kw.

The Post Street sub-station, also located in the heart of the city, distributes power from all four plants for city use with 30,000-kw. capacity.

The Little Falls station, 30 miles northwest of Spokane, contains four units, each consisting of a 9,000-hp. I. P. Morris horizontal twin turbine direct-connected to a 5,500-kw., three-phase, 60-cycle, 4,000-volt General Electric generator. The water wheels will develop a maximum of 11,250 hp. each when operated under a 73-ft. head running at 150 rev. per min. Each generator is guaranteed to operate continuously under a 25 per cent overload.

The Long Lake development is situated on the Spokane river about 24 miles northwest of the city. At this point the river makes a complete horseshoe bend and passes through a box canyon, the walls of which are of granite formation rising to a height of about 350 ft. above the water, making an ideal location for the highest spillway dam in existence, with the water station around the bend about 250 feet from the dam.

Drainage and Ventilating System

An elaborate and complete drainage system has been constructed, consisting of a network of drains on the foundation, which are connected by pipes to the inspection and drainage tunnels, which will relieve an upward pressure other than that due to back water that might exist. The ventilating system consists of four fans, each having a capacity of 50,000 cu. ft. per minute at 1¾ oz. pressure. The head gates which, are 21 by 19 feet, are constructed of I beams and plates, and operated on wheels which travel on a vertical 60-lb. rail concreted in the face of the dam. The wheel axles are mounted on bronze eccentrics, which allow a forward movement of ¾-in. and to which rubber belting is fastened which acts as the seal and rests on the flange of an I beam concreted into the dam. When the gate is in closed position, it is held against the dam on the seals by the water pressure, making it absolutely water tight.

Long Lake Plant Equipment

The installation consists of four 13,900-kva. generators direct-connected to four 22,500-hp. turbines. The turbines are of the double inflow horizontal Francis type, manufactured by the I. P. Morris Company. Each unit consists of 83-inch twin runners enclosed in cast iron volt casings and operates at a speed of 200 r.p.m. under a 168-ft. effective head with a guaranteed efficiency at ¾ load of 85 per cent.

On the second floor are the high tension oil switches, disconnecting switches, and high tension buses. Above this on the third floor are the lightning arresters, high tension current and potential transformers, line disconnecting switches with the choke coils in the open alcoves at line entrances. On the roof are placed the steel structures conveying the lines to the horn gaps through the roof bushings to the lightning arresters below.

The station is designed with clearances for 110,000 volts through the disconnecting switches and high tension buses are the only parts of the equipment so insulated at this time. All 4,000-volt oil switches are motor-operated Type H-6. All 70,000-volt oil switches are solenoid-operated Type K-15. All 110,000-volt oil switches are Type F. K.-36. The arrangement of oil switches in the circuits is such as to give a liberal degree of flexibility in operation, facilities, re-arrangement in case of a breakdown of one of the oil switches, and allow disconnecting any one of them for repairs without shutting down any generator, transformer or line. The synchronizing equipment is installed in duplicate and allows synchronizing between generators, any generator to any line, or between lines.

Demand and Supply

The company will start construction very soon of a high power transmission line from the Long Lake plant to Chewelah, for service to the magnesite quarries and mining properties in the district.

The line, carrying 5,000 horsepower, will be about 35 miles long and will connect with the power line of the Stevens County Light and Power Company, the plant of which is insufficient to take care of the rapidly growing needs of the district.

The total developed horsepower in the Inland Empire territory is as follows:

		Hp.
Washington Water Power Co.	Post Falls	15,000
Washington Water Power Co.	City Plant	12,000
Washington Water Power Co.	Little Falls	36,000
Washington Water Power Co.	Long Lake	90,000
City of Spokane	Up-River	3,000
Spokane & Eastern Ry. & Power	Nine Mile	16,000
Montana Power Co.	Thompson Falls	50,000
Similkameen River		5,000
Metaline Falls		6,000
Miscellaneous		6,000
	Total horsepower,	239,000

MISSION RANGE POWER HOUSE

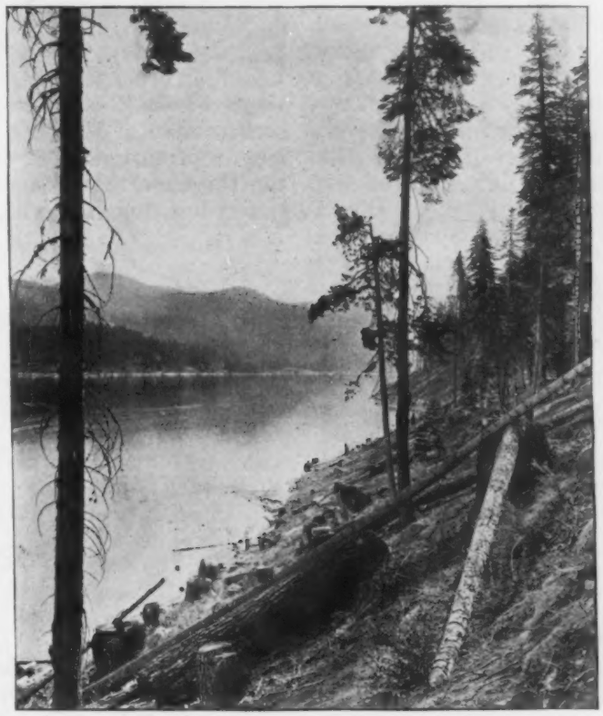
Power house of the Mission Range Power Company, located on Big Creek in Montana. The power house installation consists of two 200-kva. generators which supply power to the town of Polsen. The current is generated at 2300 volts and transmitted to the town, a distance of six miles, at 16,500 volts.

Hydroelectric Development in Southern California

BY W. A. BRACKENRIDGE

(The following masterly description of the hydroelectric possibilities of Big Creek and the upper San Joaquin River by W. A. Brackenridge, Senior Vice-President of the Southern California Edison Company, tells of the detailed plans worked out by that company for the exploitation of these streams in the high Sierras. This one California stream system has power possibilities exceeding those of any state outside of the Western states, excepting New York. —The Editor.)

The territory served by the Southern California Edison Company is still young in terms of power load. The demand for power during the last decade has more than doubled. The present offers load of all classes in magnitudes that tax our ability to construct plants to supply it. One million acres of land await the electric driven pump to bring them into cultivation and production, representing a possible load of 300,000 horsepower. Industry from the East and Middle West is just beginning to be attracted to Southern California by her natural advantages, market accessibility, and power resources. The electrification of certain railroads of Southern California is being brought closer to realization by the diminishing supply and increased price of fuel oil, and by the necessity for a more intense movement of traffic over natural channels of transportation. Without an adequate supply of electric power continuously available, the future growth of the country will be seriously retarded.



Huntington Lake Reservoir at an elevation of 7000 feet, and with a storage capacity of 88,400 acre feet, supplies Big Creek Power House Nos. 1 and 2, each with an installed capacity of 32,000 kw.

The responsibility to supply this power naturally falls to the Southern California Edison Company by reason of its position in the field. In accepting this responsibility the Southern California Edison Company has projected into the future a construction program which began actively to be executed immediately after the armistice. The program, while extensive, is at the same time flexible to permit of minor modifications to meet the varying needs of the time. Its execution will require the expenditure for new construction of ten million ($10,000,000) dollars per year for the next ten years. This vast amount of money will be invested in hydroelectric developments to keep pace with the demands for power.

Investment in hydroelectric properties of this class is especially attractive because of its stability and its freedom from the effects of fluctuations in the fuel market.

For its future supply of hydroelectric energy, the Southern Californa Edison Company looks mainly to the San Joaquin River. The Kern River offers some future developments, but they are not comparable, either in magnitude, or in facilities for water storage, with the possible power developments of the San Joaquin River.

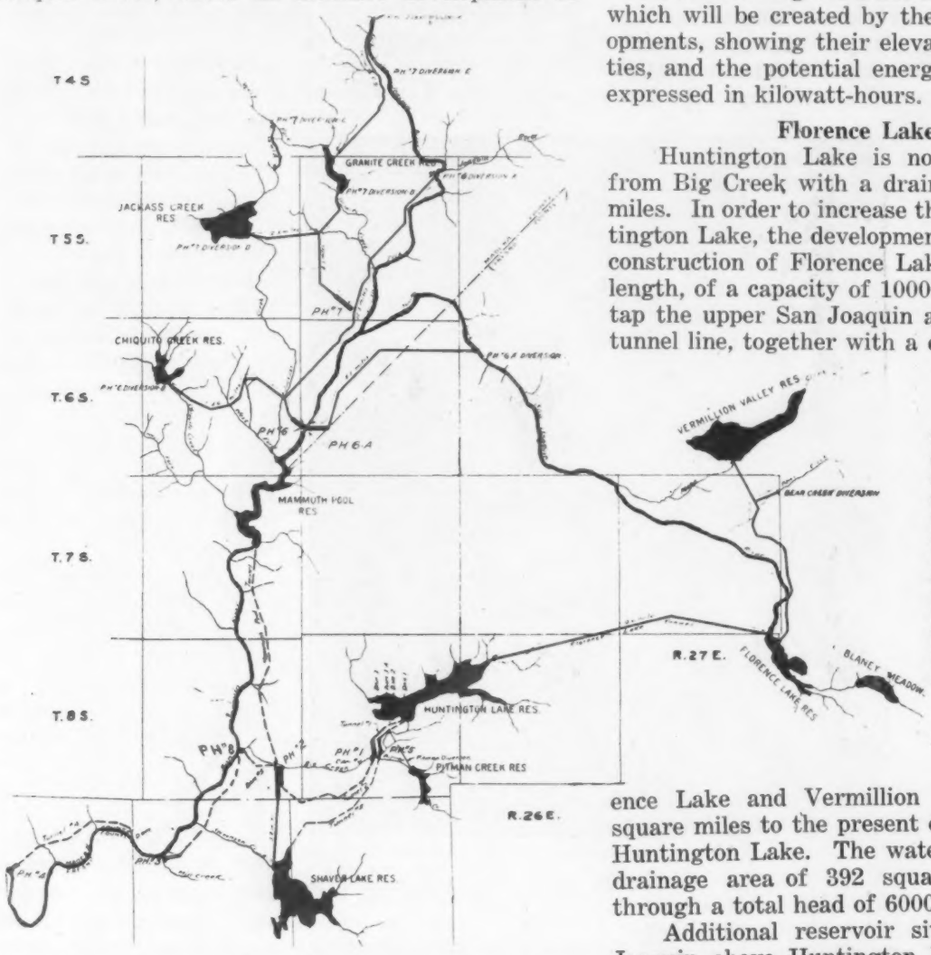
The present developments of the Edison Company on the San Joaquin River consist of Huntington Lake reservoir with a storage capacity of 88,400 acre feet at an elevation of approximately 7000 feet, supplying Big Creek Power Houses Nos. 1 and 2, each with an installed capacity of 32,000 kw., operating under static heads of 2130 feet and 1860 feet respectively. These developments form only the nucleus of the ultimate development possibilities, which will aggregate 868,000 horsepower.

The general scheme for developing this great source of hydroelectric power consists of the construction of a chain of power houses in series between Huntington Lake with an elevation of 7000 feet, and the tail water of Big Creek Power House No. 4 at an elevation of 1000 feet, giving an overall static head in excess of one mile, through which the falling waters from Huntington Lake will be converted to useful power. This chain of power houses in the order of their location, beginning at Huntington Lake, will consist of Power Houses Nos. 1, 2, 3, and 4. The upper end of this chain of power houses has two branches, one leading from Huntington Lake through Power House No. 1, and the other from Huntington Lake through another power house designated at Power House No. 5, which will be located at an elevation approximately 500 feet above Power House No. 1. The tail water from Power House No. 5 will discharge through a tunnel line into Shaver Lake, from whence it will ultimately be conducted through Power house No. 2 and the remainder of the power

houses in the chain. This development plan will make the waters of Shaver Lake, with an ultimate reservoir capacity of 146,000 acre feet, at an elevation of 5400 feet, available for use through all of the plants of the chain of power houses, except Power House No. 1.

Additional Sites

In addition to this chain of power houses using the stored waters of Huntington Lake and Shaver Lake, two other power sites, not using the waters from Huntington and Shaver Lakes, will be developed. One of these power sites, designated as Power House No. 7, located on the middle fork of the San Joaquin River, offers an ultimate development of



This map, taken in connection with the cut of the development on page 504, shows the general conditions attending the Big Creek development. The fact that the south fork of the San Joaquin river swings around in a great bend to the north explains how the waters from the upper reaches may be used at such high heads.

40,000 horsepower under a head of 1900 feet. The other, known as Power House No. 6, is located on the main San Joaquin River above its junction with Big Creek, and is capable of a development of 147,000 hp. at a head of 1650 feet.

The entire plan of ultimate power development is shown on the accompanying map of the San Joaquin River and its tributaries.

The principal hydraulic features of the project are shown in schematic form in the vertical projection of the territory showing the tunnel lines, pressure pipe lines, reservoirs, and power plants.

Table No. 1 gives in tabulated form a list of all the power houses included in the project with their static heads, installed horsepower, and annual output in kilowatt-hours.

TABLE NO. 1
BIG CREEK POWER PROJECT
ULTIMATE DEVELOPMENTS

Plant	Static Head feet	Installed Hp.	Annual Output Kw. hr.
Power House No. 1	2,130	86,000	353,000,000
Power House No. 2	....	193,000	855,000,000
Huntington Lake Water	1,860	.....	.....
Shaver Lake Water	2,400	.....	.....
Power House No. 3	825	120,000	525,000,000
Power House No. 4	380	54,000	250,000,000
Power House No. 5	1,480	108,000	291,000,000
Power House No. 6	1,650	147,000	590,000,000
Power House No. 7	1,900	40,000	148,000,000
Power House No. 8	717	120,000	525,000,000
TOTAL		868,000	3,537,000,000

NOTE.—Power Houses Nos. 1 and 2 have been in operation since 1913, each with a capacity of 32,000 kw.

Table No. 2 gives a list of the storage reservoirs which will be created by the ultimate power developments, showing their elevations, acre feet capacities, and the potential energy represented thereby, expressed in kilowatt-hours.

Florence Lake Tunnel

Huntington Lake is now supplied exclusively from Big Creek with a drainage area of 79 square miles. In order to increase the water supply to Huntington Lake, the development program included the construction of Florence Lake tunnel, 10.5 miles in length, of a capacity of 1000 second feet, which will tap the upper San Joaquin at Florence Lake. This tunnel line, together with a ditch line between Florence Lake and Vermillion Valley, will add 312.7 square miles to the present drainage area supplying Huntington Lake. The water yield from the entire drainage area of 392 square miles will be used through a total head of 6000 feet.

Additional reservoir sites on the Upper San Joaquin above Huntington Lake will be developed to an aggregate capacity of 145,000 acre feet at Florence Lake, Vermillion Valley, and Blaney Meadows, and their stored water diverted through Florence Lake tunnel into Huntington Lake for use

TABLE NO. 2
BIG CREEK POWER PROJECT
STORAGE RESERVOIRS
ULTIMATE DEVELOPMENT

	Elevation	Acre Feet Capacity	Equivalent kw. hr. yield through all Power Houses
Vermillion Valley	7,500	90,000	396,000,000
Florence Lake	7,300	40,000	176,000,000
Blaney Meadows	7,500	15,000	66,000,000
Huntington Lake	6,950	88,000	388,000,000
Shaver Lake	5,370	146,000	455,000,000
Granite Creek Reservoir	6,980	22,000	89,000,000
Jackass Creek Reservoir	7,000	27,000	109,000,000
Chiquito Creek Reservoir	5,000	18,000	47,000,000
Mammoth Pool Reservoir	3,000	28,000	37,000,000
TOTAL		474,000	1,763,000,000

through the entire chain of power houses below Huntington Lake.

The completion of this project will make available for use through the chain of power houses between Huntington Lake and the tail water of Power House No. 4, additional hydroelectric energy amount-

The long distance high voltage transmission lines on the Southern California Edison Company's Big Creek system extend a distance of 241 miles and operate at 150,000 volts. These were the first commercial transmission lines in the world to be operated at a potential as high as this.

ing to 1,400,000,000 kw-hr., also reservoir control over this energy through Power Houses Nos. 1, 2, 3, 4, 5, and 8.

Shaver Lake

Shaver Lake is located below Huntington Lake at an elevation of 5400 feet on the south side of Big Creek Canyon, and directly south of Big Creek Power House No. 2, a distance of 3.8 miles. Its ultimate development will create a storage reservoir with a capacity of 146,000 acre feet. The drainage area naturally draining into Shaver Lake is 31.9 square miles. Shaver Lake will be used in connection with the Big Creek power system by connecting it through Power House No. 5 to Huntington Lake, requiring a tunnel line 5.75 miles in length through solid rock, with a capacity of 1000 second feet. Power House No. 5 will be developed to an ultimate capacity of 108,000 hp. under a head of 1480 feet.

At such times as the flood waters coming through Florence Lake tunnel from the head waters of the San Joaquin river are beyond the capacity of Huntington Lake to store them, Power House No. 5 and the tunnel therefrom to Shaver Lake will be used to conduct the waters into Shaver Lake, where they will be stored until the most economical use can be made of them for power development through Power Houses Nos. 2, 8, 3, and 4.

During a year of excessive precipitation, Shaver Lake reservoir will serve as a storage medium in which to conserve the flood waters of sub-normal precipitation.

From Shaver Lake a tunnel line 2.6 miles in length with a capacity of 600 second feet will conduct the waters to the penstocks of Big Creek No. 2, where they will again enter the conduits leading through the chain of power houses, beginning at Big Creek No. 2 and continuing through Power Houses Nos. 8, 3, and 4.

Pitman Creek

Pitman Creek waters at the present time enter the Big Creek system at the tail water of Big Creek Plant No. 1 and are utilized through Big Creek Power House No. 2, where they produce an average of 30,000,000 kw-hr. per year.

The waters of Pitman Creek, as at present utilized, are not capable of being stored to a limited degree in the small reservoir which receives the tail water from Big Creek Plant No. 1 and forms the intake to the tunnel line leading to Big Creek No. 2.

These waters, after discharging from Big Creek No. 2, will be used through additional Power Houses Nos. 8, 3, and 4, to be constructed below Power House No. 2, through which they will produce an average of 28,000,000 kw-hr. per year.

For the purpose of securing reservoir control over these waters and also to make available from them an additional 30,000,000 kw-hr. per year by using them also through Power House No. 1, one phase of the future developments includes the construction of a diversion dam on Pitman Creek at an elevation which will permit the diversion of the Pitman Creek waters into Huntington Lake, where they will be subject to reservoir control and will in addition be available for use through Power House No. 1.

Mammoth Pool Tunnel

Without the construction of Mammoth Pool Tunnel, the waters of the Main San Joaquin River will not join the waters from Huntington Lake and Shaver Lake until the tail waters of Big Creek No.

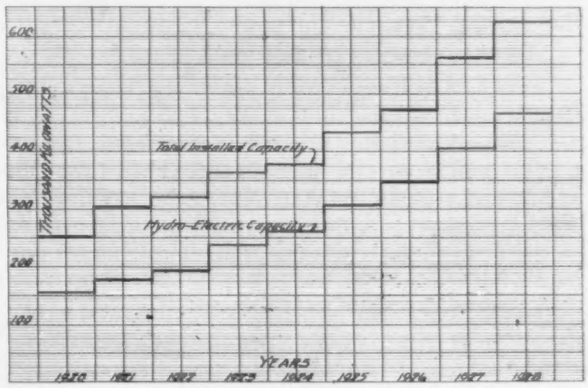


Chart of system capacity. The new developments being undertaken by the Company will supply a constantly increasing demand for power.

8 are reached, beyond which point they will be used jointly with the discharge from Big Creek No. 8 through Power Houses Nos. 3 and 4, but not through Power House No. 8.

The waters of the Main San Joaquin River can be made to do work through Power House No. 8 also by the construction of Mammoth Pool Tunnel. This project consists of the construction of a diversion dam on the main San Joaquin River at an elevation slightly above the tail water of Big Creek No. 2 plant, and the construction of a tunnel therefrom through solid rock a distance of 9.5 miles and of 1000 second feet capacity, to the tail water of Big Creek No. 2. From this point the waters will enter

the tunnel lines to Big Creek No. 8 and will be used through plants Nos. 8, 3, and 4. The construction of the tunnel will make possible the additional production in Power House No. 8 of 252,000,000 kw-hr.

In addition to the increased energy output by the utilization of the main river through Plant No. 8, there will be created on the main river back of the diversion dam a storage reservoir which will have a beneficial value from a regulation standpoint, in that it will permit of a greater flexibility in handling peak loads.

The general plan to bring into production the power resources on the San Joaquin River is:

1st. Complete the utilization of water from Big Creek and Pitman Creek through Power Houses Nos. 1 and 2, up to an installation of three units in each power house.

2nd. Develop the storage possibilities on Shaver Lake and construct a conduit therefrom to Power House No. 2 to augment the water supply from Big Creek and Pitman Creek.

3rd. Construct Power House Nos. 2, 3, and 4 in succession up to a development of two or three units in each power house.

4th. Construct Florence Lake Tunnel and divert the waters of the Upper San Joaquin River into Huntington Lake.

5th. Complete Mammoth Pool Tunnel and divert the main San Joaquin River through Power House No. 8.

6th. Develop the water resources north of Mammoth Pool on the San Joaquin River and tributaries through Power House Nos. 6 and 7.

The probable rate at which these power developments will be made is shown on Table No. 3, which is the generation program for the decade 1920-30, which the Southern California Edison Company expects to find necessary to carry through to satisfy the growing demands for power in its territory.

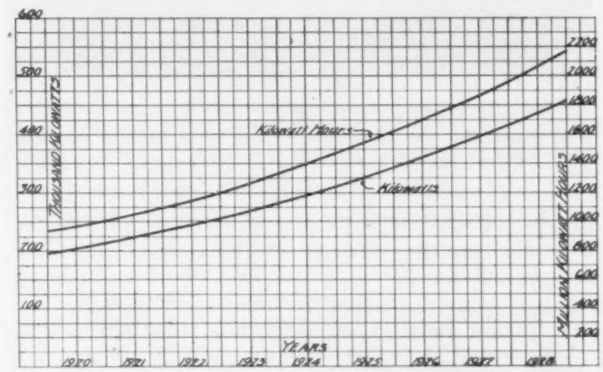
Transmission Voltage

Energy is transmitted from the present Big Creek power plants to Los Angeles, a distance of 241 miles, over two aluminum steel core circuits. Each circuit is carried on a separate steel tower line and is operated at 150,000 volts.

TABLE NO. 3
GENERATION PROGRAM
PERIOD 1920-1930

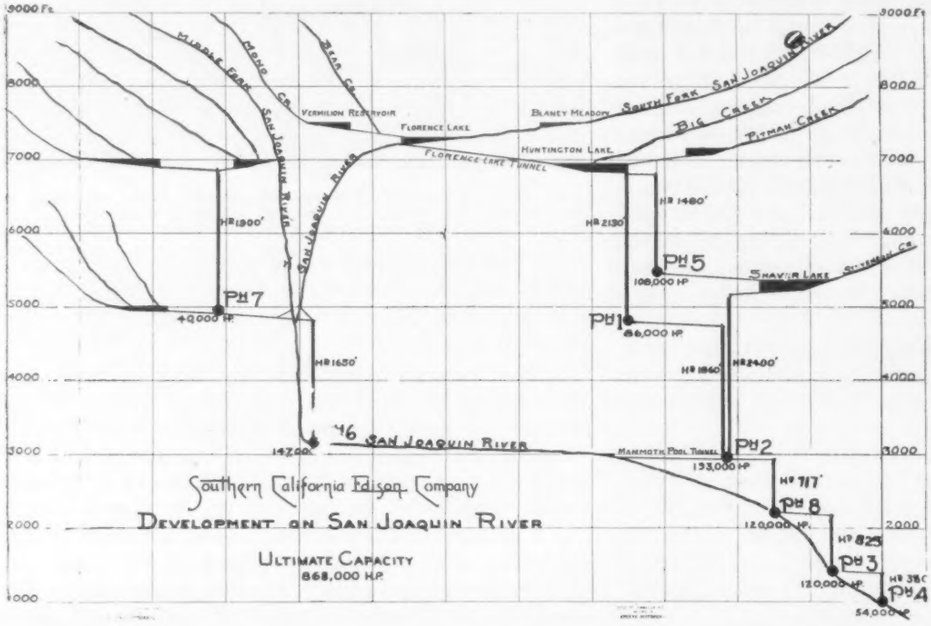
Year		Kw. Hydro	Kw. Steam
1920	Additions to Big Creek Power House No. 2....	16,000	.....
1920	Kern No. 3.....	30,000	.....
1921	Long Beach No. 4.....	.....	30,000
1921	Big Creek Power House No. 8.....	22,500	.....
1922	Additions to Big Creek Power House No. 1....	16,000	.....
1923	Big Creek Power House No. 3.....	45,000	.....
1924	Big Creek Power House No. 3.....	22,500	.....
1925	Big Creek Power House No. 4.....	40,000	.....
1926	Big Creek Power House No. 5.....	20,000	.....
1926	Additions to Big Creek Power House No. 2....	20,000	.....
1927	Additions to Big Creek Plants.....	60,000	.....
1927	Additions to Steam Plants.....	.....	30,000
1928	Additions to Big Creek Plants.....	60,000	.....
1929	Additions to Big Creek Plants.....	60,000	.....
1930	Additions to Big Creek Plants.....	60,000	.....
	Probable additions within period.....	472,000	60,000

These were the first commercial transmission lines in the world to be operated at a potential as high as 150,000 volts. Their operation has been singularly free from trouble, so much so that plans are now under way to convert them for operation at 220,000 volts. Their capacity to transmit load will



System load curve of the Southern California Edison Company. The demand for power during the last ten years has more than doubled.

be doubled by this change and the necessity of immediately constructing additional lines to transmit the production of new plants being brought in will not have to be made until a later date. The higher voltage not only has the advantage of requiring a smaller investment per unit of load transmitted, but is also more economical to operate.



Plan of a chain of power houses on the San Joaquin River and its tributaries planned by the Southern California Edison Company.
The overall static head on this system is in excess of one mile, and the ultimate installed capacity, 868,000 hp.

Each line, when converted to 220,000 volts, will be capable of transmitting 100,000 kw., giving a total capacity for the two existing lines of 200,000 kw.

To secure the same capacity by the construction of additional 150,000-volt transmission lines would require an investment of $10,000,000 in excess of the cost of converting the present lines from 150,000 to 220,000 volts. The conversion will, therefore, effect a saving in investment of the amount for the present increase in load carrying capacity, and a corresponding amount for future transmission line requirements.

Kern River Developments

In addition to the Big Creek power project, the Southern California Edison Company has located power sites on the Kern River, where it now has in operation two plants, Kern River No. 1 with an installation of 20,000 kw., and the Borel Plant with an installation of 10,000 kw.

Farther up the Kern River above Borel three additional power sites have been located, which have been designated as Kern No. 3, Kern No. 4 and Kern No. 5. The Kern No. 3 plant is now under construction and is expected to be in operation by the end of this year.

The effective heads, the installed horsepower which it is expected will be made, and the output in kilowatt-hours for these three plants, is given in Table No. 4.

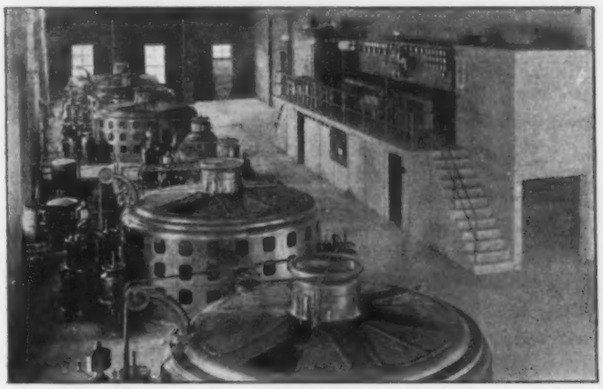
TABLE NO. 4
KERN RIVER PROJECT
ULTIMATE DEVELOPMENT

	Eff. Head Feet	Installed H. P.	Annual Output Kw. hr.
Kern River No. 3	860	40,000	180,000,000
Kern River No. 4	850	40,000	175,000,000
Kern River No. 5	1,350	40,000	175,000,000
TOTAL		120,000	530,000,000

Electrical Development on the Salt River Project

(Electric pumping is one of the increasingly important loads of the West, and the part which it plays in modern agriculture is evidenced by the frequent development of power systems in connection with irrigation projects. A large-scale example of this is described in the following interesting account of the power plants on the Salt River project, developed by the U. S. Reclamation Service.—The Editor.)

The Salt River project is primarily an irrigation agricultural project. Irrigation was practiced in this valley for some years previous, the success obtained being only partial, due to inadequate facility to utilize the many possibilities.



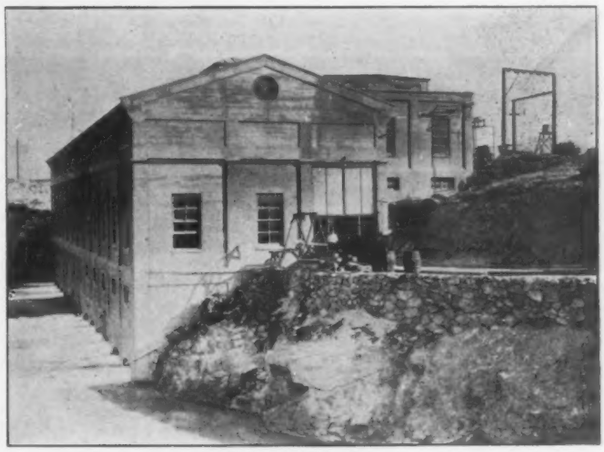
The Cross Cut power plant has six generators and two exciters. The switchboard and controlling device consist of a 14-panel bench board and a 3-panel direct current board, mounted on a raised reinforced concrete platform.

The Reclamation Service, under the Reclamation Act, constructed on the Salt River an impounding dam capable of storing nearly 2,500,000 acre feet of water together with the necessary diversion dams, canals and distributing laterals for approximately 230,000 acres.

To facilitate the construction of a storage dam, a temporary power plant was constructed at what is now the site of the main power plant located at the Roosevelt Dam. Hydraulic power for operating this plant was obtained by diverting the water from the Salt river into a power canal of some 20 miles in length conveyed to a point on the bluff above the power site, and from that point to hydraulic turbines by means of a penstock. This plant was the start of the present power system on the Salt River project. It was intended that the power generated would be utilized principally in pumping water in the valley for agricultural purposes. The phenomenal growth of the Salt River Valley made it necessary to utilize other power sites along the main canals in order that the demand for power could be met.

This power system in connection with the entire irrigation system of the Salt River project is being operated by the Salt River Valley Water Users' Association. The total of the entire generating capacity, consisting of 19,000 kw., is hydraulic.

The power is used in the city of Phoenix and seven smaller towns located within the Salt River Valley, and two of the largest mining companies use it for mining and mill purposes. The Salt River project makes use of the other portion of the power



Cross Cut Power House on the Salt River project. This plant operates under a head of 119 feet with a maximum flow of 750 second feet and is constructed with a special reinforced concrete forebay and two reinforced concrete penstocks 2240 feet in length.

for construction work and operating about sixty pumping plants that are being used for the combined purposes of developing water for irrigation purposes and maintaining a low water plane under the cultivated lands to prevent these becoming water-logged.

The Roosevelt Power Plant

The Roosevelt Power Plant is located at the toe of the Roosevelt Dam and consists of six units with a total capacity of 10,000 kw. These units are of the vertical type with generators mounted on the turbine housings. The water supply is received from the lake created by the dam, conveyed through the dam by means of two penstocks. One penstock is 10 feet in diameter and has its upper end 80 feet above the river bed. The other is 7 feet in diameter and leaves the dam at river level. Variable head turbines are used and so arranged as to utilize any head between 0 and 225 feet according to the height of water in the lake. The turbines are governed by 5 Lombard and 1 Woodward oil pressure governors. The governors are 2300 volts and 25-cycle.

Control is from a bench board and all switches are remote electrically operated. At the transformer house, 700 ft. distant, are located six 1050-kva. banks of 2300/45,000-volt transformers which connect with the lines to Salt River Valley and Miami, the latter place being the mining district.

The South Consolidated Power Plant

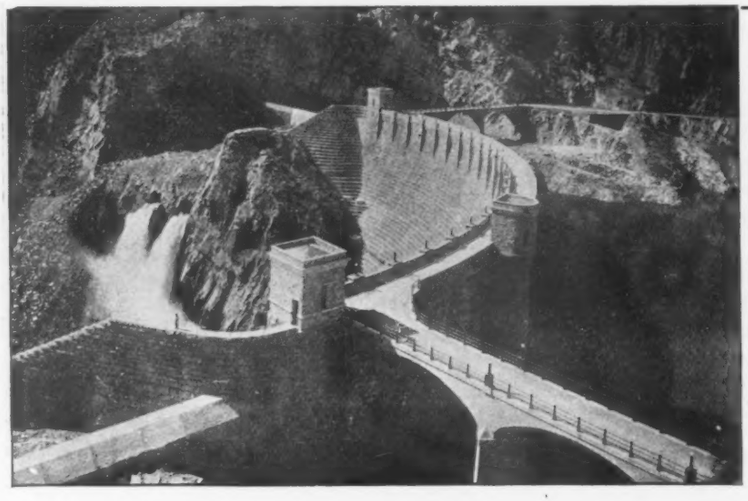
The South Consolidated Power Plant is located on one of the main irrigation canals at a point where there is available a head of 31 feet. The amount of water delivered to this power plant varies with the irrigation demand, reaching a maximum of 1250 second feet. The installation consists of two open flume type S. Morgan Smith, double runner, horizontal, single discharge turbines 1400 hp. each, direct connected to two 2300-volt, 1000-kva. generators. The generators are controlled from a switchboard of usual design with manually operated oil switches. Two banks of transformers step up this current from 2300 volts to 45,000 volts and is then transmitted a distance of about eight miles where it is connected to the main line from the Roosevelt Power Plant to Phoenix.

The Cross Cut Power Plant

The Cross Cut plant offers more features of interest to engineers, probably, than any other part of the system. It was required that a plant be designed to operate under a head of 119 feet with a maximum flow of 750 second feet. It was further desired that high efficiency be obtained at varying heads and that the flow of water be not impeded, as the water which passes through this power plant is utilized for irrigation purposes and the flow must not depend upon the load changes on the plant. To meet these conditions the design included a reinforced forebay from which two reinforced concrete penstocks 7 feet in diameter, approximately 2240 feet in length, led to the power plant. The plant has six generators and two exciters; three generators and one exciter being connected with each penstock.

Each unit consists of a Pelton vertical impulse turbine. The water is delivered to each wheel through six nozzles which are in turn controlled by individual needle valves. Direct connected to the turbine shaft is an 875-kva. Westinghouse, 25-cycle, 11,000-volt generator. The rotating elements of both the water wheels and generators are carried on Kingsbury thrust bearings located on top of the generator spiders. One exciter is used to furnish the excitation of three units and consists of a 300-hp. Pelton water wheel similar to the above described turbine, and a 250-kw. 110-volt direct current generator. When a unit is in operation all of the nozzles are wide open. The water applied to the wheel is controlled by means of stream deflectors operated by oil pressure governors of Pelton-Doble make. The official acceptance efficiency test made after the completion of this plant showed a maximum over all efficiency of 79.26%.

The switchboard and controlling device consists of a 14-panel bench board and a 3-panel direct current board, all of which are mounted on a raised reinforced concrete platform located about the middle of the generating room along the unused wall. The switch gallery and bus bar rooms are connected with, but separated by a wall, from the main generating room. It consists of a 11,000-volt room on the ground floor and a 44,000-volt room directly



The power plant located at the toe of the Roosevelt Dam receives its water supply through two penstocks, one ten feet, the other seven feet in diameter. There are six units with a total capacity of 100,000 kilowatts.

above. Parallel busses and necessary switching devices provide for both the 11,000 and 44,000 volts. Part of the current generated at this plant is transmitted over the 11,000-volt distributing system and part is stepped up by means of four banks of transformers, each bank consisting of three 500-kva. single-phase transformers. All the switches are electrically operated automatic oil circuit breakers, remote controlled from the bench board located in the generating room.

The Chandler Power Plant

The Chandler plant is located on what is known as the Tempe Cross Cut Canal, situated about two miles north and west of Mesa, and operates under a 40-ft. head with a maximum flow of about 300 second feet of water. The plant consists of one S. Morgan Smith double runner, single discharge, flume type, horizontal turbine, direct connected to a 600-kva. General Electric 2300-volt induction generator. The power delivered from this unit is stepped up to 11,000 volts and fed into the 11,000-volt distributing system. This plant requires very little attention and operates equally as successfully as the other plants on the system.

The distributing system consists of 45,000 and 11,000-volt lines, there being 162 miles of 45,000-volt line connecting Roosevelt Power Plant and the Inspiration Consolidated Copper Company's mines and mills located at Miami, Arizona, and a line connecting the Roosevelt Power Plant with the valley plants and the city of Phoenix. The greater part of this line is carried on steel towers designed to use suspension type insulators, double three-phase circuit with a ground wire over each circuit. The branch line feeding from the main steel tower line to the Magma Copper Company, a distance of 30 miles, is single circuit pin type insulators carried on wood poles. The 11,000-volt distributing system consists of about 81 miles of single circuit, three-phase lines mounted on both wood and steel poles. This system is used primarily to supply power to the various pumping plants operated by the Association.

The Arizona Falls Power Plant

The Arizona Falls plant is located on the Arizona Canal about 20 miles below a point where water is diverted from the river into the canal system and about 10 miles from the city of Phoenix. Except for being smaller in capacity this plant is a duplicate of the South Consolidated plant. This plant is also constructed across an irrigation canal and operates under a head of approximately 19 ft. The installation consists of two 725-hp. S. Morgan Smith open flume, horizontal type turbines, each direct connected to a 425-kw., 11,000-volt generator.

Future Plans

As a large part of the power available on this project is dependent upon water being required for irrigation purposes it has been necessary to favor customers whose power requirements would be consistent with the irrigation season. This condition fits in very favorably with the requirements throughout the valley as a large acreage of land is available that is using this power for pumping purposes during the irrigation season, resulting in maintaining a daily load factor unusually high, often reaching 90% and averaging 80%. This is made possible because mines using this power operate 24 hours a day and irrigation is carried on continuously throughout the entire irrigation season.

It is the intention of the Association to extend its distributing system throughout the entire Salt River project consisting of 230,000 acres, to supply electric power for domestic and ranch purposes. Electricity on the farm has been a subject much discussed but has not been extensively carried out in many localities. This project affords most favorable opportunities to put this plan in operation and it is hoped that many of the intricate problems arising through this plan will be worked out in such a way that other communities can receive the benefit of the experience gained on the Salt River project.

CONSTRUCTION UNDER WAY IN CALIFORNIA

At the present time there are under way, contracts let or the machinery ordered for steam and hydroelectric installations in California that amount to 273,000 kilowatts. The following list gives the location of the project, type, probable date of completion and estimated capacity.

NORTHERN CALIFORNIA

	Kilowatts
Great Western Power Company:	
Caribou Power House, North Fork, Feather River; completed March, 1921; hydro	40,000
Pacific Gas and Electric Company:	
Oakland; November, 1920; steam	12,500
Pit River; January, 1921; hydro	24,000
San Joaquin Light & Power Corporation:	
Bakersfield; June 1, 1920; steam	12,500
Elk Hill; January 1, 1921; gas burning steam	12,500
Kerckhoff, San Joaquin River; Oct., 1920; hydro	30,000
Southern California Edison Company:	
Big Creek No. 2; November, 1920; hydro	16,500
Big Creek No. 8; March 1, 1921; hydro	22,500
Northern California total,	170,500

SOUTHERN CALIFORNIA

Southern California Edison Company:	
Kern River No. 3; November, 1920; hydro	30,000
Long Beach; February, 1921; steam	30,000
City of Los Angeles:	
San Francisquito Creek; July, 1920; hydro	20,000
Los Angeles Gas and Electric Corporation:	
Los Angeles; January, 1921; steam	10,000
Southern Sierras Power Company:	
Adams Power House; January, 1921; hydro	2,500
Lavining Power House; October, 1921; hydro	10,000
Southern California total	102,500
Total Hydro Installations,	195,500
Total Steam Installations	77,500
Total,	273,000

As has been pointed out, the majority of these plants will not be finished in time to help out the present shortage of power, but they will prevent a recurrence of this situation for the next few years. The construction program of the power companies, not including the above plants, is great enough to allow them to keep ahead of the increased demand unless there is an unusual growth in the uses of electricity in the next decade. In the next eight years California's peak is expected to reach 1,475,990 kw., and to meet this plans have been made to install 978,050 kw. additional, bringing the total installed capacity of California power plants to 1,925,150 kw.

Economies in a Modern Steam Power Plant

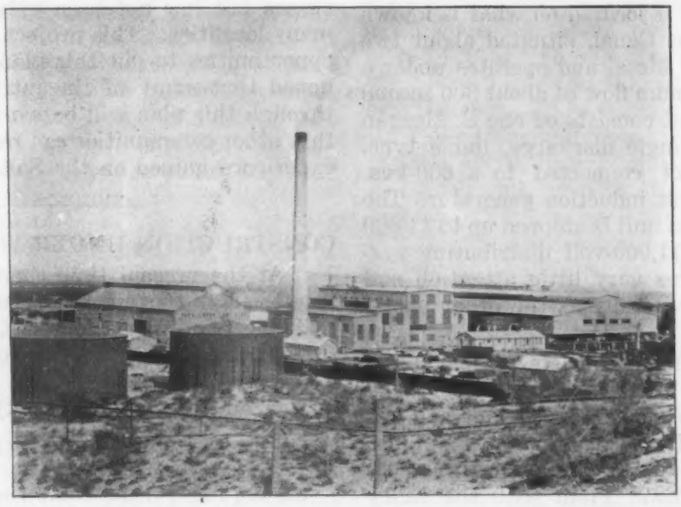
BY EDWIN A. ROGERS

(The equipment and practical operation of a power plant are susceptible of a number of adaptations in securing the highest possible efficiency under a certain set of conditions. The following article gives some of the technical details of a modern plant in the Southwest. The author has been chief engineer in charge of the plant for two years.—The Editor.)

The power plant of the New Cornelia Copper Company at Ajo, Arizona, has already been described in connection with other modern steam power plants in this state, and some data given as to economies obtained.* It is the intention to give in this article additional data on these economies and methods of operation used in obtaining them.

Type of Equipment

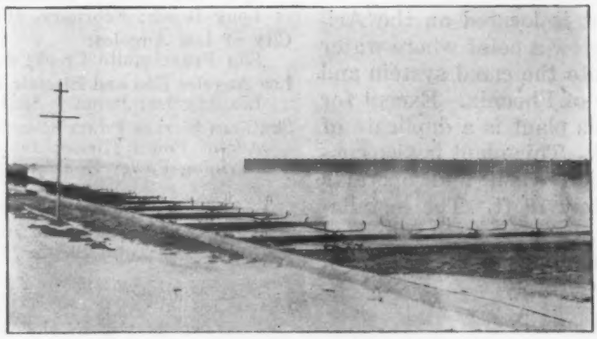
The generating equipment consists of two General Electric turbo-generators rated at 7500 kilowatts at 80% power factor. The generators are 3-phase, 60-cycle, 2300-volts at 1800 r.p.m. The turbines are designed to use steam at 240 pounds pressure and 140 degrees superheat.



Exterior view of power plant showing tapered onstruction of reinforced concrete stack, 220 feet high.

The condensing equipment consists of Wheeler surface condensers, Wheeler dry vacuum and centrifugal hot well pumps. Duplicate hot well pumps, one motor driven and one turbine driven, are provided for each condenser. Each condenser has its own motor-driven centrifugal circulating water pump for supplying the cooling water from the pond.

The boiler equipment consists of five Stirling boilers rated at 825 hp. each. They are operated at a pressure of 255 pounds and as normally operated deliver steam at 110 degrees superheat. Being equipped with asbestos insulation and steel casings, radiation and air infiltration losses are reduced to a minimum. The gases leaving the boilers pass through Green fuel economizers which are arranged so that with four boilers in operation, each economizer takes care of two boilers. Natural draft is used and as the air temperatures are high in summer, a stack 220 feet high is necessary. This stack is of reinforced concrete, double for part of its height, and the tapered construction gives not only good mechanical proportions but a pleasing appearance. Feed water heaters are provided which utilize the steam from the rotative dry vacuum pumps and feed water pumps to heat the feed water before it goes to the economizers. The pumps for handling the feed water are turbine driven centrifugals, the exhaust steam from the turbine going to the feed heater.



This cooling pond measures 150 by 400 ft. and is one of the largest in the country. Each condenser in the plant has its own motor-driven centrifugal circulating water pump for supplying the cooling water from the pond.

Boiler Efficiency

The firing of the boilers is controlled by a Moore automatic regulating system which is one of the main contributing factors in the maintaining of the high boiler efficiencies obtained at this plant. The furnaces are of the Hammel-Peabody type and Hammel oil burners are used. That the automatic control of the dampers produces excellent results is shown by the boiler efficiencies maintained. With the dampers properly set the regulator maintains a draft condition which gives almost perfect combustion as shown by the gas analyzer, the per cent of CO_2 in the gases leaving the boilers being maintained between limits of 13.0% and 14.5%. The following figures show the boiler room results for the month of December, 1919:

Load on boilers in per cent of rating	91.0%
Gross boiler plus economizer efficiency	84.5%
Gross boiler efficiency	80.0%
Amount of steam used for atomizing oil	1.0%
Net boiler efficiency	79.0%

These percentages do not take into consideration the additional amount of steam used for atomizing the oil with hand firing, but refer to excess air only. When the boilers were fired by hand the atomizing steam was supplied through a line on which there is no flow meter and consequently accu-

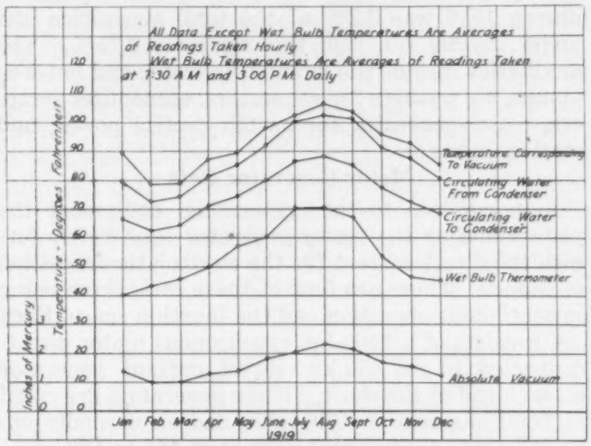
*See "Economy of Certain Arizona Steam-Electric Power Plants Using Oil Fuel," by C. R. Weymouth, presented before the American Society of Mechanical Engineers at Detroit meeting on June 16, 1919. Also "A Record in Fuel Oil Economy in Arizona Plants," by C. R. Weymouth, Journal of Electricity for August 1, 1919.

rate data on this item is not available. It has been the writer's experience that with hand firing the atomizing steam will vary from 2.0% to 4.0% of the steam generated, depending on the skill and experience of the operator. Observations on the boilers at this plant would indicate a steam consumption of at least 2.0% for atomizing, which is a loss of 1.0% over the amount shown for automatic control.

With regard to the efficiency of the automatic control of the firing of the boilers as compared with hand firing, it has been found that the boiler room efficiency is 4% to 5% higher when the regulators are in operation than when firing and damper setting are done by hand. The comparison has been made at times when the regulators were taken out of service for inspection and general overhauling, and the firing and regulating of dampers done entirely by hand.

Operation of Automatic Regulators

The automatic regulators do not relieve the fireman of all responsibility in connection with the firing, however, for it is necessary to watch the burners carefully to see that they are working properly. It occasionally happens that a burner becomes choked or partially so with carbon, which reduces


All Data Except Wet Bulb Temperatures Are Averages of Readings Taken Hourly
Wet Bulb Temperatures Are Averages of Readings Taken at 7:30 A.M. and 3:00 P.M. Daily
Temperature - Degrees Fahrenheit
Inches of Mercury
Temperature Corresponding To Vacuum
Circulating Water From Condenser
Circulating Water To Condenser
Wet Bulb Thermometer
Absolute Vacuum
Jan Feb Mar Apr May June July Aug Sept Oct Nov Dec
1919

In the summer the circulating water for the condensers gets very warm, and the vacuum is influenced by a scale forming in the condenser tubes. Much lower economies prevail during the period of these extreme temperatures.

the size of the flame. This results in a considerable amount of excess air in this particular boiler and unless the burner is changed, may result in a serious loss in efficiency. The fireman must be trained, furthermore, to understand the value of the gas analysis in its relation to efficient operation. This is necessary because it is essential for him to make adjustments on the main damper regulator to compensate for changes in draft conditions due to atmospheric changes. Thus for instance, if the dampers are set during the day to give proper combustion and at night the air cools down considerably, the stack draft increases and more air will be drawn into the boilers than is necessary. When the fireman finds that this condition exists, by turning a hand wheel and tightening a spring on the damper regulator the dampers are set for the new draft conditions and automatically take care of changes in load as before. It has been found in this plant that this adjustment for changes in draft due to atmospheric changes is a very important part of maintaining high economies.

Maintaining Economy

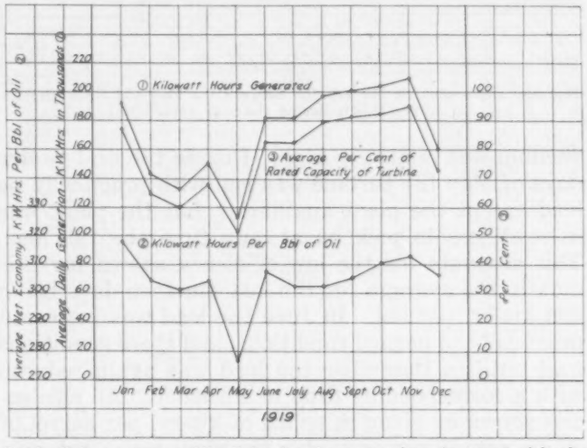
In order to obtain a maximum of effort on the part of the operating force, in maintaining the proper economies, the economy is worked out for each watch and posted daily. The rivalry thus promoted has aided materially in maintaining good operating results in the plant. The results thus posted every day are:

Kilowatt-hours generated.
Barrels of fuel oil used.
Pounds of water evaporated.
Kilowatt-hours per bbl. of oil.
Pounds of water per pound of oil.

The equipment used to obtain this and other data is as follows:

For accurately measuring the fuel oil two carefully calibrated tanks are used, it being possible to obtain the oil consumption within less than one-half of one per cent.

A Cochrane V notch meter in the feed water heater and a Venturi meter on the feed water line to the boilers give the amount of water evaporated.


① Kilowatt Hours Generated
② Kilowatt Hours Per Bbl of Oil
③ Average Per Cent of Rated Capacity of Turbine
Average Wet Economy K.W.Hrs Per Bbl of Oil
Average Daily Generation - K.W.Hrs in Thousands
Per Cent
Jan Feb Mar Apr May June July Aug Sept Oct Nov Dec
1919

Load efficiency curve. All efficiencies shown or given in terms of kw-hr. per barrel of oil are net, all power used in the plant being deducted from the total generation before figuring the efficiency

A General Electric steam flow meter gives the amount of steam used for atomizing the fuel oil.

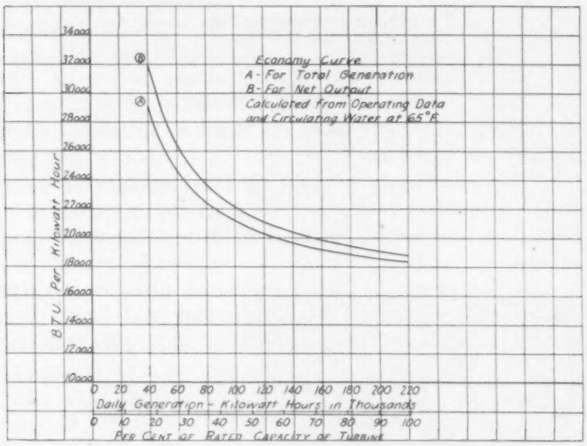
The boilers are provided with draft gauges, superheated steam thermometers, flue gas thermometers and Uehling CO_2 recorders. Thermometers are also provided on the economizers for gases entering and leaving, and water entering and leaving.

Readings are taken hourly and logged, of all of these instruments, and thus it is an easy matter to locate any losses of efficiency which may occur.

As the town of Ajo is situated in the desert, extreme temperatures prevail in the summer months and consequently much lower economies are obtained during this period. The circulating water for the condensers gets very warm, this resulting in a material loss in vacuum. The vacuum is also influenced by scale forming in the condenser tubes, but this loss can be easily remedied by cleaning the tubes out with a proper cleaner. To determine when it is

necessary to remove the scale, tests are run, from which a heat balance for the condenser can be worked out. From this heat balance the heat transfer through the tubes can be determined and when this figure falls below a certain point the tubes are cleaned.

In spite of the very low vacuum during the summer months, fairly good efficiencies can be obtained, as shown by the load-efficiency curve. During February, March and April the load was very low, which accounts for the low efficiencies obtained, when the



Economy curve showing the relation between the load and B.t.u. supplied per kw-hr. during the year 1919.

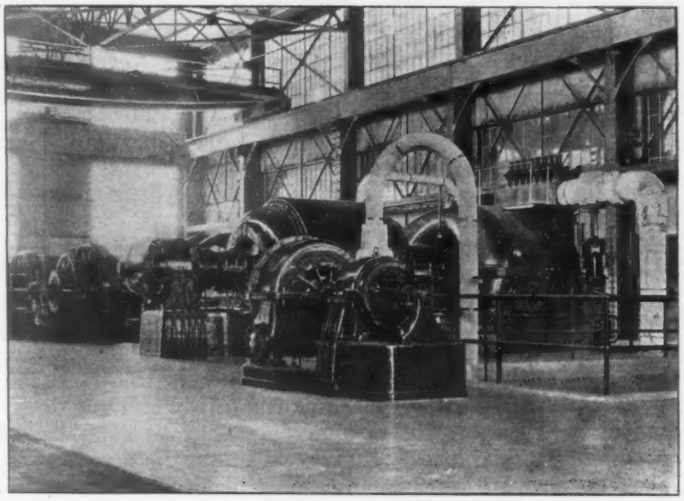
vacuum was relatively high. During the first twelve days of May the turbine was run with practically no load except the plant auxiliaries, but the plant was in readiness to pick up at any time the full load. This accounts for the low efficiency shown for this month, the average for the last nineteen days being 303 kw-hr. per bbl. In June the load was increased practically to normal conditions, and these conditions held until in December the load was again reduced with a corresponding drop in efficiency. All efficiencies shown or given in terms of kw-hr. per barrel of oil are net, all power used in the plant being deducted from the total generation before figuring the efficiency.

The best economy obtained by the plant during 1919 was for the last eleven days of January. During this period the load averaged 8085 kw. The temperature of the circulating water was 68.8 degrees, and the vacuum 1.28 inches absolute. The average net economy was 323.1 kw-hr. per bbl. Individual days showed as high as 327 kw-hr. per bbl., and individual shifts better than 330 kw-hr. per bbl., but these results are not as accurate as those taken over a longer period. The economy curve showing the relation between the load and B.t.u. supplied per kw-hr. generated is calculated from the results actually obtained in the plant during the year 1919. In some cases on the low loads correction was made for circulating water temperature, as the loads occurred when the water was about 75°. At the higher ratings, however, the curve corresponds to the actual existing temperatures and conditions.

Notwithstanding the fact that with a cooling pond and spray nozzles it is necessary to pump the circulating water against a considerably greater head than should ordinarily be necessary in a sea-water plant, the power used by the auxiliaries compares quite favorably with plants of the latter type. The average amount of power used by the auxiliaries during 1919 was 3.2% of the total generation and under normal full load this figure is 2.75%. The auxiliaries include the circulating water and hot-well pumps, air washers for generators, economizer scrapers, motor-generator for switch control power, and station lights.

Motor-Generator Sets

In addition to the generating equipment the plant contains the motor-generator sets which furnish the direct current for the electrolytic deposition of copper. There are four of these sets, three being in continuous operation and the fourth a spare. Each set consists of a 2400-hp. synchronous motor direct-connected to an 850-kw. direct current generator on each end of the shaft. These generators are rated at 5000 amperes at 170 volts, and as normally operated carry the full load current at 160 to 170 volts. Thus with three units in service there is a total load of 30,000 amperes at 160 to 170 volts on the d.c.



Turbine room of the New Cornelia Copper Company plant at Ajo, Arizona. An auxiliary exciter unit made by the Allis-Chalmers Company is shown in the foreground. Behind this is one of the turbo-generators and in the background can be seen the four Westinghouse motor-generator sets. Three of these sets are in continuous operation, and carry a total load of 33,000 amperes at 160 to 170 volts on the d.c. side for twenty-four hours a day.

side. As this load is continuous for 24 hours a day it gives the plant a very high load factor, at times 94% and averaging about 90%. This aids materially in maintaining high economies. The motors being synchronous make it possible to keep the power factor at 98 to 99%, which has made it possible to carry peak loads of 10,000 kw. on one of the main generators.

Accompanying ilustrations show the power plant, cooling pond and interior of the plant. The cooling pond is one of the largest in the country, being 150 feet wide by 400 feet long. The turbine room is shown, an auxiliary exciter unit made by the Allis-Chalmers Company appearing in the foreground, then one of the turbo-generators, and in the background the four Westinghouse motor-generator sets. The design and installation of the plant were made by Chas. C. Moore and Company, Engineers, with the approval of A. G. McGregor, consulting engineer for the New Cornelia Copper Company.

Although the production of copper by the New Cornelia Copper Company did not begin until early in 1917, it was quickly developed into one of Arizona's big producers and today stands among the foremost in the country. As most of the copper produced is deposited electrolytically from the acid which leaches it from the ore, and as most of the process from the firing of the blasts to the loading of the copper on the cars is dependent on electricity, the New Cornelia Copper Company can be classed with the big industries of the West which "Do It Electrically."

Electrical Service in the Northwest

BY GEO. L. MYERS

(In any survey of electrical resources and development, statistics from a single company are significant of the growth of the district served by that company. The following interesting summary of the activities of one northwestern utility is by the assistant to the president of the Pacific Power & Light Company.—The Editor.)

Pacific Power & Light Company operates electric, gas, water and electric railway properties in the states of Idaho, Oregon and Washington. The value of its properties is about $19,000,000, and it had a gross revenue in 1919 of $2,175,922. Of this gross the relative amount in percentage for each class of service was electricity 72%, gas 13.5%, railway 9%, and water 5.5%. Therefore, slightly less than three-quarters of its gross revenue is from electric service. There has been added to plant account since its organization in July, 1910, for property acquired, improvements and additions, almost $7,000,000, or 57%.

The company serves 65 communities, 61 with electricity, seven with gas, four with water, and two with electric railways, exclusive of interurban. At commencement of operation it served 15 communities, 13 with electricity, five with gas, three with water and two with electric railways. The population served in 1910 was approximately 75,000. As of December 31, 1919, it was estimated to be in excess of 157,000, or an increase of 109%. Electric, gas and water customers increased from 15,858 in 1910 to 42,203 in 1919, or 166%.

Power Resources and Load

In 1910 there was a hydroelectric generating capacity of 6600 kw., and a steam capacity of 4850 kw., or a total of 11,450 kw. The present capacity in hydro-electric is 15,775 kw. and in steam 6240 kw., or a total of 22,015 kw., an increase in total capacity of 92%. The company since 1910 has made physical connection with the Washington Water Power Company of Spokane, Washington, at Lind, Washington, and Northwestern Electric Company of Portland, at White Salmon, Washington, from which to draw for additional power or sell its own surplus. The kilowatt-hour output, generated and purchased, for the eight-year period, 1912-1919, increased from 36,348,770 to 71,952,068, or 97%. The connected load for the 1912-1919 period increased from 18,966 to 48,144 kilowatts, or 154%.

The mileage in high voltage transmission lines in 1910 was 181, and in 1919 it was 515, or an increase of 184%. Of the total of 515 miles 14.5 are 11,000 volts, 87.5 miles 25,000 volts, and 413 miles 66,000 volts. The mileage in distribution lines increased from 215 in 1910 to 790 in 1919, or 267%.

The electric railway service is an urban and interurban system at Walla Walla, Washington, of approximately 28 miles, operated by Walla Walla Valley Railway Company, a subsidiary of the Pacific Company; and an urban system at Astoria, Oregon, of 5.5 miles, operated by the Pacific Company.

The foregoing facts are significant of the comparative growth and development of the company in value, gross revenue, service and property. Since the acquisition of its various properties, practically all of its electric properties have been welded together and the electric properties in eastern Washington, constituting the Yakima-Walla Walla system, inclusive of the Pendleton, Oregon, district, form a complete unit of continuous high voltage transmission lines. Those electric properties that have not been interconnected are in The Dalles-Hood river and Astoria-Seaside districts in Oregon, and Goldendale district in Washington. The electric property at White Salmon, Washington, has physical connection with The Dalles-Hood river district. This has been conducive to increased operating efficiency and economy and a greater assurance of continuity of service than was possible when the properties were operated separately and as isolated units.

Territory Served

The company operates in a territory principally agricultural and horticultural. There is a constantly growing demand for power. The gradual development of the agricultural and horticultural resources has brought about an increasing population with a

greater need and larger use of electric service for ordinary domestic conveniences and necessities. This has resulted in the development of industries allied with the products of agriculture and horticulture, such as beet sugar factories, canneries, dehydration plants, refrigeration plants, flour mills, feed mills, packing plants, creameries, condensaries, etc., which have necessarily increased the demands for electric power. The centers of greatest industrial activity are at Vancouver, Washington, and Astoria, Oregon, occupied in shipbuilding, lumbering, fisheries, dairying, milling and miscellaneous manufactures. The company has been meeting the increased demands for power as they arose, even though financial conditions have made it difficult to do so. Of the company's gross revenue 9% is from irrigation motors, amounting to 5778 horsepower, or 10.2% of the connected load. There are extensive areas susceptible of development through irrigation by pumping and the use of these unproductive areas in the development of communities of which they are a part is dependent upon the increased use of electric power.

Future Development

The company's plans for the future in respect to major developments have not taken definite form, awaiting the proper readjustment of economic life and public opinion to a somewhat normal and conservative state. The only electrical development of magnitude now being made by the company is at Astoria, Oregon. To provide additional power capacity a steam plant is being built, the first installation of which consists of a 3000-kw. turbo generator, at a cost of $700,000, and an additional investment of $30,000 is being made in distribution lines to connect the new steam plant with the distribution system. The present power capacity at Astoria and Seaside is 2490 kw., and the capacity of the electric steam plant of the Hammond Lumber Company, from which this company purchases power, is 4100 kw., or a total present steam power capacity of 6590 kw. The present power capacity, together with the capacity of the new electric steam plant, will make an available total power capacity of 10,340 kw. at Astoria.

The company's territory within its field of operations has excellent possibilities of industrial development. There are varied resources in raw materials and large possibilities of industrial development allied with the intense growth of agriculture, horticulture and stock raising, which is becoming more diversified. Additional future uses for electric power are in manufactures of the products of timber and wool, chemicals and fertilizers, and it will only be a question of time when the steam railroads will be electrified, all of which will make large demands for the use of undeveloped water power. There are adequate undeveloped resources in water power within the company's territory to take care of future demands. These resources will be developed as rapidly as economic justification and financial conditions permit. Some potential industries will be largely dependent upon economical power. Most of them, as is generally the case, will not be, as their location will be dependent upon resources and facilities that are interdependent in determining location, such as source and extent of raw materials, labor supply, transportation facilities, and proximity to markets, not the least of which is a constructive public opinion that will encourage the investment of capital.

Cumulative Cooperation

BY S. M. KENNEDY

(The complexity of modern civilization has created a state of affairs in which no individual can claim genuine isolation. What one man does reacts upon the community, and conversely, the good of the whole is in the last analysis the good of the individual. This involuntary responsibility necessitates the most comprehensive kind of cooperation, as discussed here by the vice-president and general agent of the Southern California Edison Company in the concluding article of his series.—The Editor.)

There are some words in the English language whose original meanings have changed somewhat in the course of time, and it would seem as if the word "cooperation" were one of this class. The modern definition of cooperation is "the act of laboring together with others for a common end."

The Cooperative Society

The pioneer of cooperation in Great Britain and America was a man named Robert Owen, and his type of cooperation bordered on communism. Cooperation has always consisted of two kinds—simple cooperation, when individuals strive to help each other in the same employment, and complex cooperation, when they attempt to do so in different employments. In Robert Owen's time, about one hundred years ago, there were great philanthropic ideas advanced along the lines of community cooperation, many of them meeting with failure, and the best meeting with only a limited success. During the nineteenth century the cooperative society spread to France, Germany and America, but did not take hold in the same manner it did in Britain. In the latter country the most notable and perhaps the most successful experiment was in Rochdale, which has been called "the Mecca of cooperation." There they developed what is termed "cooperation in production and cooperation in distribution," the latter being designed to save profits by cutting out the middle man. In the United States, cooperation of the community type like Rochdale has made little progress. There has been a great development of mutual insurance and building and loan societies, which are examples of cooperative action. Cooperative distribution has attained no marked success, and cooperative production still less. Profit sharing is the nearest approach to this principle in manufacturing concerns. Cooperation in the last century had more or less of a concrete form, but today in the public utility business it is dealt with more in the abstract and might best be termed "The Cooperative Spirit." The co-

operative spirit today does not aim at cutting out any wing of an industry, the middle man or any other man, but rather aims at helping each wing properly to fulfill its particular function.

The Cooperative Spirit

It was Elbert Hubbard who said, "The valuable man in any business, is the man who can and will cooperate with other men. Men succeed only as they utilize the services and ideas of other men." The spirit of cooperation is a vital element in every successful business; it tends to the fullest development of the individual and necessarily of the business as a whole, and fosters a feeling that gives a man a joy in his work. The spirit of cooperation means not only acting or laboring together to a common end, which may be more or less mechanical, but it means putting the soul into the work; all having at heart the one purpose, thinking, planning and dreaming it, as well as working for it, cheerfully and enthusiastically. That is cooperation in its highest form, and there are few businesses and fewer industries that have yet developed the cooperative spirit to such a degree. Yet it is entirely possible to instill this vital force into an organization and to foster and maintain it. It may be termed an intangible force, like personality, on which it depends to a considerable extent. In many organizations in the public utility business, little or no attention has been paid to the development of the spirit of cooperation in the past, and such organizations have suffered in consequence. It is fast becoming a recognized factor in economy — confidence and strength from the standpoint of the progressive management, and of development, opportunity and advancement from that of the thinking employe. In a large organization the spirit of cooperation means team work and something more. It is intangible and yet a real force, as is the college spirit to a university, esprit de corps to a regiment, civic pride to a municipality, and patriotism to a nation.

In applying the term "cumulative cooperation" to the central station industry, the idea is to show the advantages to be derived from "heaping together" the results to be obtained from developing the spirit of cooperation in the various branches, so that the industry as a whole may feel its beneficial effects. It seems advisable to start with the individual employe and first discuss the subject of

Cooperation with One's Self

On the face of it, self cooperation may sound paradoxical. It takes two to make a quarrel, and some may think it takes at least two to practice cooperation. On the other hand, there is a verse in the Bible which reads, "But when thou doest alms, let not thy right hand know what thy left hand doeth." It may be granted that this is metaphorical, but if it is not possible to segregate part of one's self for one purpose, it is surely possible to cooperate with all parts of one's makeup for another purpose. An employe of a utility company may have decided talents along certain lines. He may have the very qualities which are needed for important positions ahead—but he may be handicapped by himself. If he is careless about his personal appearance, if his clothes are untidy, his shoes down at the heel, his collar soiled or his hat dirty, then he is condemning himself in the eyes of others who are observing him. Such indifference is not self cooperation. Again, in the daily round of his work, is he prompt, or is he tardy? Is he at his desk at the appointed hour in the morning, and after lunch is he back at the hour expected? Does he waste the company's time? Does he keep other employes awaiting his appearance in order to transact the company's business? If he does, then he is doing the reverse of cooperating with himself. Others are noting his movements and they won't forget when promotions are under consideration. His company has framed certain rules and regulations for its employes to go by. Does he go by them, or "go-by" them? If the rules are disregarded, then he is not cooperating with himself. Further, in transacting business with the company's patrons, does the employe always treat these patrons with proper consideration? Is his voice gentle, attitude conciliating and his words courteous? If not, then there is a distinct absence of self cooperation. Is he doing his best at all times and under all circumstances, in his business and in his home, during his work and at his play? Does he hold that inward desire to do what is right and appear to the greatest advantage? Then, if he does, he has acquired the spirit of self cooperation, a valuable asset on which he will some day realize substantial dividends.

Cooperation Among Employes

To accomplish the greatest possible results, employes as individuals must cooperate with each other. Business without cooperation is like sound without harmony,—it stunts individual character, strangles ability and exaggerates difficulties. It is a tremendous handicap for men to work under such conditions. Take the volume of business being handled by a force in which lack of harmony is conspicuous—put it in the hands of an organization that is working in the right spirit and all the leaks and waste that accompany discord will at once be converted into savings of time and money. The spirit of co-

Good feeling and the spirit of cooperation among employes is not a mere adjunct to business; it is an essential factor, and should be cultivated in every possible way.

operation is just as important between the different departments of an organization as it is between the different workers in each department. Each individual and each department has its functions. The manner of doing the work finally means a success or failure of the whole concern. Of what ultimate good to himself or to the organization is a well balanced man in a well run department, if the other members and departments making up the organization cannot or will not cooperate with each other and for the benefit of all? In the long run, a man is going to get just about what he is entitled to—that is, what he earns. If he works selfishly, which is short-sighted-

Cooperative advertising has been a marked feature of recent electrical activities, and is proving of immense value both to individual firms and to the industry as a whole in propagating the electrical idea.

edly, and cannot cooperate with his fellow employes, and does not consider the interests of the organization as a whole, he will not go very far. On the other hand, the man who earnestly cooperates with his fellows, works loyally for the good of his company, which is his good also, will find before long that the net results of his work will show for themselves. Such a man is a credit and a profit to an organization — and his future is assured. There never was a time in the history of this country when there was so much industrial unrest and so much vague dissatisfaction among workers. There seems to be a recklessness among wage earners that has no parallel. They need guidance and leadership of the right character more than anything else. One of the chief duties of an executive is to do everything that will help to develop this spirit of loyal, hearty, enthusiastic cooperation, from the heads of departments down to the newest employe, filling the smallest position. It can be done by taking a live personal interest in their welfare, and encouraging them to improve their present conditions and future prospects by cultivating the spirit of cooperation, and getting out of it the inherent benefits which accrue to those who believe in it. Managers of today and some of the future must have the faculty to manage men—which is a more difficult problem than operating a motor or running a generator. The human element in industry is still larger than the mechanical element, and managers, superintendents, and foremen often lose, or maybe deliberately throw away their largest asset by failing to create and develop that spirit of cooperation, that friendly relationship with subordinates, which makes for the highest success. Organizations and business enterprises seem to grow bigger as the years go by, but personality is also increasing in value. The executive or manager of today, to be successful, must through his personality create a spirit of cooperation and loyalty—not to himself alone, but to the great organization of which he for the time being is the head, and of which his lieutenants are important parts. Such an organization can accomplish anything in reason. A great ironmaster once said, "Take away all our factories and trade, our avenues of transportation, our money, but leave me an organization, and in four years I shall have re-established myself." No man could talk with such assurance if the true spirit of cooperation did not permeate his organization from top to bottom.

Cooperation with the Industry

In what is termed the electrical industry, there are numerous branches each presumably fulfilling its own particular function. This condition does not prevail with other utilities such as water, gas and telephone companies, except to a limited extent. The principal segregations in the electrical industry are, the central station, the manufacturer, the jobber, the dealer and the contractor—each branch has a mission of its own, but all are tied in together—distinct as the billows, yet one as the sea. However, if one branch of the industry does not properly fulfill its function then the work must be done by one or more of the other branches. When the business of distributing electrical energy first started, it was all in the hands of the central station, which was then distributor, manufacturer, contractor, dealer and everything else. As the business developed, the other branches sprang into existence and the central station operators were glad to concentrate on the production and distribution of electrical energy. But where and when the other branches did not keep pace with their growing responsibilities, then the central station had still to perform the functions of the weaker or lagging branches. In some parts of the country there were, and there are today, many dissensions among the various branches of the industry. One branch will claim the other is eating into its business and another branch will claim that its neighbor is not doing its duty. In some localities conditions were strained to a point of open war. It has been said that before cooperation comes in any line there is always competition pushed to a point that threatens destruction and promises chaos; then to avert ruin, men look for a better way, a plan that conserves and economizes, and this better way is found in cooperation. Some attempts have been made at so-called cooperation, when the plans really spelled coercion. Men were threatened instead of persuaded, and as a natural sequence, such combinations were short-lived and the last state was worse than the first. There is no industry in which cooperation can be made so effectual as in the electrical, but the union must have the real spirit and not the

imitation. There is a positive cooperation and a negative cooperation. A farmer was one day driving a team of horses attached to a cultivator, and a stranger stopped to look on. "Your horses work well together," said the stranger. "Yes," replied the farmer, "one is willing to do all the work, and the other is willing to let him." This is a sample of negative cooperation which is not infrequently seen where others are struggling to make the positive or real cooperation a success. Cooperation in the electrical industry should be definite and simple; simple, because it should not involve methods that may be termed experimental, freaky or untried, and definite, because the end to be looked for is a better understanding, through consistent and persistent educational endeavors, between the different branches of the industry, and between the individuals who make up the different branches. No attempts should be made to dictate to any individual or branch of the business what must be done. No one part of the industry should say to one neighbor, "Thou shalt not!" or to another, "You must not!" and no one should be threatened, intimidated or cajoled. On the other hand, every reasonable effort should be made to educate and inform each branch of the industry as to how its own particular business may be more efficiently handled, and a constant effort made to assist each branch more intelligently to understand some of the problems and perplexities of the other branches. Real cooperation is an appeal to the intelligence of the individual rather than an appeal to the old-time prejudices of any group. It should be the crystallization of a desire to have each branch of the business recognize the responsibilities it owes to the other branches of the industry, and to teach the individual that, after all, he may to some extent be his brother's keeper. Discord in the electrical industry stays development, for there cannot be a canker in one branch without affecting the whole. On the other hand, true cooperation benefits all. The contractor gets more orders on a profitable basis and is able to accumulate capital and extend his business. The work of the contractor means that the dealer sells more supplies and appliances. The dealer looks to the jobber to meet his increased demands. The jobber sends larger requisitions on the manufacturer, and with it all, the central station adds more consumers and sells more electric energy. Such cooperation means harmony and advancement. It brings about cooperative methods for displaying and merchandising, cooperative advertising, and cooperative distribution of educational literature and electrical knowledge. But with it all, there should be modesty and appreciation. In the past the thing that has usually made cooperation successful has been a moderate amount of adversity. Too great prosperity has wrecked many well intentioned cooperative schemes. Prosperity is apt to make men reckless and forgetful of their obligations to others, but in the electrical industry, cooperation, if properly guided, should only be strengthened and cemented by the prosperity of the individuals who are its beneficiaries.

Cooperation with the Community

A man's value to the community in which he lives lies in his ability to think individually and act collectively. A man connected with a public utility cannot be of proper value to himself and cannot properly advance the interests of the organization with which he is connected unless he cooperates with the community wherein he dwells and has his business connections. In all civic organizations, such as boards of trade, chambers of commerce, merchants' associations and business men's clubs, the live public utility man should be a conspicuous figure. In the construction of the modern automobile, there is the engine, the running gear, and the tonneau. In all civic organizations like those referred to, there are the parts to correspond with the automobile. First, the executive, which represents the motive power and resembles the engine; second, the men who do the work and carry the load, which corresponds with the running gear of the auto; third, the men who are carried along, but who do nothing but look pleasant. These correspond to the tonneau of the car. Now the public utility man should be a hustler and faithfully represent the progressive character of his business. His standing in the community will usually reflect the standing of his company. In his connection with civic bodies, he should not be one of those who always ride in the tonneau and do nothing. He should be alive and aggressive, and he will learn that both himself and his company will be the gainers by his brushing up against and cooperating with the other men. In local politics, however, the public utility man should not be aggressive, otherwise he may injure his value to his company and maybe impair its standing. The utility man should in all political affairs take no public stand unless in a crisis. Political parties come and go, but the central station business goes on continually. He should hold his own views as a private citizen and vote and act accordingly. Communities need the true spirit of cooperation among their citizens for protection and advancement. Men cannot work together, save for the common good, and active cooperation in local affairs will benefit the individuals and the business interests of those locally established.

Courting Success

The greatest game in the world is success and every man is playing his cards to win. Success is made up of many attributes and no one element in itself can assure it. The annals of successful men clearly demonstrate that all such men knew the value of cooperation—could cooperate themselves and always picked assistants who understood the meaning of the word. The young man who will commence by cooperating with himself and carry the spirit of cooperation in all his contacts with his fellows, will gradually bind success unto himself "with hoops of steel," and will eventually reap the desired fruits of cumulative cooperation.

NOTE

The articles comprising the series by Mr. Kennedy will shortly appear in book form.

A New Equation for Gravitational Force

BY DR. A. C. CREHORE

(Modifications in the current form of electromagnetic equations point to the necessity of a revision of the well-known equation of Newton, which expresses gravitational force between bodies in space. The author, one of our best known physicists, herein discusses some of the defects in the present equation and the modification of the well-known Lorentz equation, in which he answers some very pertinent objections made by Schott, a contemporary physicist, who has urged other modifications in theory. This paper constitutes the eleventh by this author appearing serially in the Journal of Electricity under the title "The New Physics."—The Editor.)

In this section we shall consider more in detail the source from which this gravitational equation was derived. It has not been derived directly from the current form of electromagnetic equations, but these have required some modification. The surprising thing is that the modification required is so little. It may be said that the above equation would never have been obtained without the use of the present form of the electromagnetic equations. This equation was obtained by taking the time average of a much longer equation, that which represents the instantaneous force between the two electrons when they are in certain positions in their orbits. Each averaging process simplifies the equation. For example, there are no terms in the above equation that refer to time. The time disappeared in taking the time average, and contributed only to the numerical coefficient. So, again, in the space average later, the terms containing X, Z and a disappeared and entered into the numerical coefficient, giving a very simple final result.

Defective Equations

In the original equation for the instantaneous force there appears in the coefficient multiplier of the equation the so-called Doppler factor,

$$A = \frac{\delta t}{\delta \tau} = 1 - \frac{Q_x R}{C R}.$$

This appears as $1/A^3$ in the coefficient of the equation. Now, when the speed is very small as compared with the velocity of light, the second term of A becomes very small, and the value of A approaches unity when the speed approaches zero. In deriving the time average of the instantaneous force, the author assumed that this factor was sensibly equal to unity. With this assumption the equation obtained is not exactly the same as that given above, but is exactly the same, if we omit the factors $m_0\beta_1^2$. To omit these quantities means that the magnitude of the force is very different, since m_0 is equal to $.898 \times 10^{-27}$, and β_1^2 of the order of 10^{-4}. Without these factors the derived force was, therefore, this great number of times larger than the gravitational force. This result is not only absurd, but it is fatal to the present form of the electromognetic equations, for we are absolutely certain that no such great force exists at these large distances. If the theory predicts them, the theory is erroneous.

Moreover, the omission of the β_1^2 is just as bad as the omission of the m_0, although it does not affect the magnitude so much, because its omission means that one body must attract the other with a different force from that exerted by the other body on the one. This is contrary to one of the best established laws we possess, due to Newton, that of equal action and reaction.

There is justification for the inclusion of both of these factors, and the fact that we obtain an equation that represents the gravitational laws faithfully in all respects when we do include them is additional justification. The justification for including the β_1^2 is that it makes the force conform to the established law of equal action and reaction. The justification for including m_0 is that without it the dimensions of the equation are not correct, and the quantities on the right of the equation do not represent a force. The dimensions of force are

$$F = L\,M\,T^{-2},$$

and the dimensions of the right member without the m_0 are on the electrostatic system of units,

$$L\,M\,T^{-2}k,$$

which cannot be the same as force. On the space-time system, putting $k = L^{-1}T$ and $M = L\,T^{-1}$, these become respectively

$$F = L^2\,T^{-3}$$

and

$$L\,T^{-3}$$

These last dimensions require to be multiplied by a velocity in order to make them equivalent to a force. That is to say, they must be multiplied by a mass. Since m_0 is a mass, and since its numerical value when coupled with the β_1^2 brings the magnitude of the force into agreement with the gravitational force, we are justified in believing that the original equations were defective in not including such a quantity. It is most significant, too, that the numerical value of the mass required to make this correction should have a value equal to the mass of the electron itself. It ought to be directly related to the electron if we are on the right track in getting at the origin of the gravitational force.

Modification of the Lorentz Equation

It must be stated here that the author has been taken to task in a long article by G. A. Schott for making what he considers an error in the derivation of the average force from the original electromagnetic equations of Lorentz. The error consists in assuming, as was done, that the Doppler factor above referred to is sensibly equal to unity. Fortunately Schott has checked the original equation for the instantaneous force with which we now begin, and finds the same result. And again, he has checked the equation that the author obtains as the time average of the force on the assumption that this Doppler factor is equal to unity, namely, the equation given above omitting the m_0 and the β_1^2. He has

gone further and has obtained a time average assuming that this Doppler factor is variable with time. The result that he thus obtains does not resemble the gravitational law in any other respect than one. This is that the force is inversely as the square of the distance. The fact that we obtain an equation that represents gravitation so exactly in the manner that has been described above is of considerable interest in itself, especially in view of the fact that it is known that the present form of the Lorentz equations is deficient in certain cases. It is our diagnosis that this is one of the cases where it requires modification, and we are particularly fortunate to have been led so near to a result which expresses the facts by sticking to the equations as far as we have without the necessity of modifying them.

A New Form of Electromagnetic Equations

Since this work was published Mega Nad Saha has derived a new form of electromagnetic equations based upon considerations of the general Minkowski space, and in accordance with the theory of relativity. His results show that the $\delta\tau$, which appears above in the expression for the Doppler factor, should be regarded as the differential of a generalized Minkowski space coordinate. This involves x, y, z and t, and does not depend upon time alone. In other words, reasons have already appeared from a quite independent source why there must be some modification in the Lorentz form of electromagnetic equations. It seems necessary to the author that these changes will eventually show that some such factor as m_0 will have to be introduced into the original equations. Also that a similar factor will appear in the so-called Doppler factor, the second term of it, which will result in its having a value that approximates unity very closely indeed.

The result of Schott, taking this factor as given above, will therefore prove to be of little value. It gives no useful result as it stands.

The above explanation has been offered for the reason that among physicists this criticism of Schott has been widely circulated. It is believed that it is fully met.

Office Records—Their Filing and Indexing

BY IRENE WARREN

(Facility of reference, and general convenience in handling filed material may be greatly increased by transferring data from letters to cards where possible. The following article, the ninth of the series by the Director of the Chicago School of Filing and Indexing, describes some of the methods of handling card record systems in various types of business.—The Editor.)

CARD RECORDS

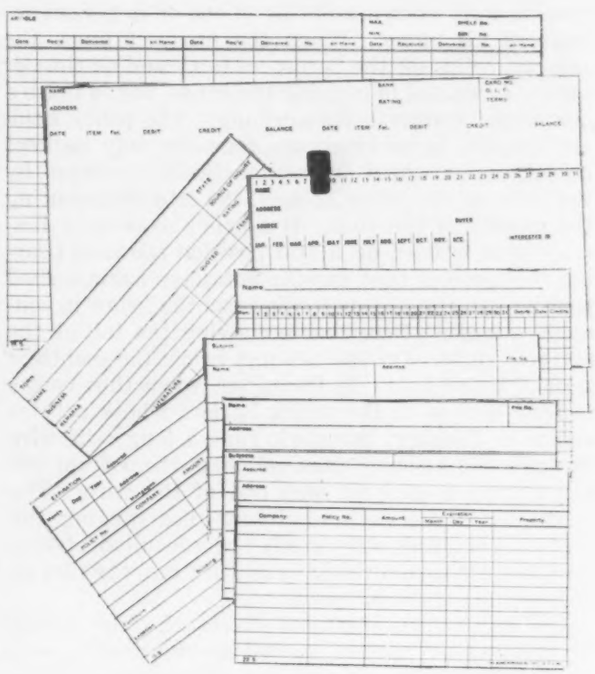
Every effort is made so to arrange the files of correspondence, orders, bills, and data of various sorts that they will index themselves. Card indexes are made only when cross references are needed, except in the case of the numeric system which always demands an alphabetic card index.

But a vast amount of information in business houses today is kept on cards, and some of these card forms are so universally used that they have become standardized and are for sale by firms selling filing equipment. Among these are cards for keeping perpetual stock records, for indexing trade catalogs, for recording information for dentists, insurance agents, banks, and other specialized lines.

Many times the information contained in letters can be made more readily available if transferred to cards. A purchase department will find it much more convenient to transfer to cards information as it is received regarding prices of items, than it will be to consult the various original letters when they wish to place an order. The file clerk should be familiar with the card forms on the market so that if one exists that will fit the company's needs for any new record desired, it may be purchased promptly and save the time and expense of printing a new form. If a new card must be planned, then attention should be given to its every detail. Many card records fail to meet the demands made on them because they have not been carefully enough thought out.

Arranging Information

First, the information to be placed on the card should be carefully assembled and arranged so that the word under which the card is to be filed stands first; like information should be grouped together; and some definite sequence of subject matter followed. It is difficult to choose a terminology as brief



Large numbers of cards are already manufactured which provide for numerous and diverse types of data. If a new form must be planned to meet a special need, the greatest care should be used in its preparation in order that it may meet all demands and really add to the efficiency of the filing system.

as that which is printed on the cards must be, and especially so if the cards are to be filled in by more than one person.

The type should be clear and small. Sometimes it is a good plan to use several different styles or sizes of type, or different colors to make the information stand out clearly. Ruled lines of varying shades, colors and number may also help to group information.

The spacing of the information is also important. The length of the line should not exceed three or four inches so the eye travels the entire length easily. The proper spacing should be planned for filling in the information by typewriting, by handwriting or by checks (√), although the latter is more apt to be inaccurate.

The firm name and printer's form number should be printed in small type in the lower left hand corner for purposes of identification and also for convenience in re-ordering stock. Do not place the firm name in large print at the top of a card which is the most valuable filing space and should be retained for more important information.

Adjustable Indicators

One arrangement of cards may be kept, as for instance the alphabetic, and yet indicate several classifications, by using tab cards, colored cards or signals. A list of employes may be kept in one alphabetic list by surnames—the men listed on white cards and the women on blue cards. A salesman has a card which he fills in with all the necessary information regarding a prospective customer. On the upper left hand corner is a tab bearing the word "Prospect." Customers and prospects are filed in one alphabetic arrangement so that there is no embarrassing wait when a caller by phone or in person announces his name. When the prospect buys, the salesman clips off the "prospect tab," and no time or money is wasted in copying the cards, nor is there a chance for errors in transcribing. The policy holders' records in an insurance company may be kept on tab cards, which are alphabetically arranged by the name of the policy holders, the tabs representing the months of the year. If a policy expires in January, it is written on a first position tab card bearing the name of that month: February has a second position tab and the succeeding months follow in consecutive order—December occupying the tab at the extreme right. On the tab just below the month is a small round hole. In December, when time comes to send notices to the policy holders whose policies expire in January, the clerk runs a long stiff wire through the January tabs and lifts them from the file, placing a cork on each end of the wire. The typist sends the notices without disarranging the cards. The cards may easily be consulted at any time and are sorted ready to go back into the files as fast as the notices are sent.

If several classifications which are to be chosen from a possible ten are wanted on one card, a card may be purchased with ten tabs, numbered or named as desired, and all but the desired tabs may be cut off when the card is filled in. There are also celluloid signals in colors, numbered, lettered, or wide enough to insert a word, which may be pasted on the top of cards to give the desired classification.

There are metal tip signals in varying colors which may be had for the months, days of the week, or bearing letters or numbers. These slide over the top of the card and permit a changing classification. The daily movement of cars may be traced across a card in railroad offices by means of such signals.

Wall maps or maps used in shallow flat drawers often supplement card indexes especially in sales records and in campaigns. Colored pins placed on the towns indicate the places where items are sold or propaganda has been undertaken. The routings of salesmen or speakers may be traced by means of colored yarns attached to the map in much the same style that campaigns were followed on maps during the war.

Distribution of Guides

Guides for card indexes may be had in metal tip or celluloid tubes for inserts, or in the flat celluloid or plain tab guides for all standard sizes and in varying colors. Alphabetic divisions ranging from 25 to 5000 divisions, consecutive numbers, states, cities and other classifications may be purchased. The guide tabs are cut in thirds, fourths, fifths, and halves. There should be a guide for every twenty-five or thirty cards to insure both accuracy and speed in handling the cards.

Visible Files

The visible files are more advantageous for many short lists where quick reference is needed than are cabinet files. They provide for cards of varying sizes and offer the same advantages in special classifications for both temporary and permanent use as described above, by means of colored cards and signals.

If all card records as well as the files for correspondence and data are placed under the supervision of a competent, trained file clerk who attends to the making and filing of all records, there will be continuity in the filing, less unnecessary duplication of records, duplicates needed will be made when the original card is written, which saves time and money, and it will be easier to know where to locate special information. In large corporations the file clerks can go to the various departments perhaps twice a day, to collect information needed for the files and to add cards made to department files. Meanwhile the department files are in good shape for use, and are free from the mistakes that are sure to occur when a busy office boy or private secretary tries to make and tuck cards away in the file during chance leisure moments.

APRIL 15th FRONTISPIECE

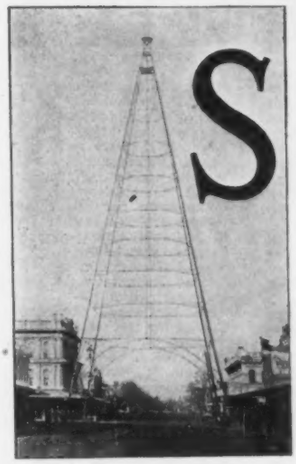
In response to an inquiry concerning our April 15th frontispiece—a fine picture of the High Sierras near the Southern California Edison Company's Big Creek system—we are pleased to give credit to the photographer, Mr. G. Haven Bishop.

Mr. Bishop is also responsible for a number of the photographs used as illustrations to the Water Power Report appearing in this issue, and for the illustrations to the article by Mr. Brackenridge.

The Oldest Central Station in the World

BY FRANK B. RAE

(Of great historic interest is the following account of the world's first central station, described by an engineer who was connected with the company from its earliest days. The details of the plant construction and illumination designs illustrate with exceptional vividness the vast strides which electrical development has made since its not very distant pioneer days.—The Editor.)



The San Jose tower, built in 1881 to supply the city with the "moonlight" illumination. It was necessary to make certain modifications in this structure later.

SOMETIME about 1876-7 the California Electric Light Company was organized, and under the direction of George Roe, as secretary and general manager, established the first central station in the country, antedating the stations of Cleveland and elsewhere in the East by some months. This first station building was a brick structure about 25 x 40 feet, located on the rear of a 50-foot lot on O'Farrell street, San Francisco, an old wooden residence on the street front serving as offices.

Power Plant Equipment

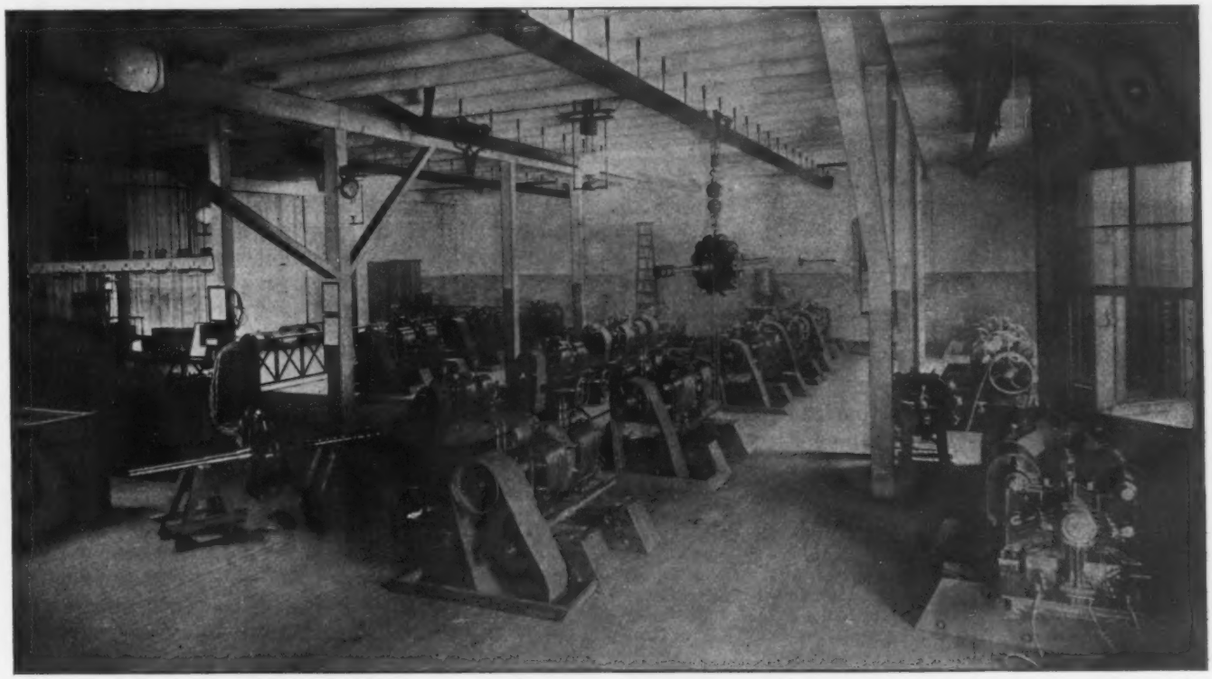
The power plant consisted of one tubular boiler of about 60 hp. as nominally rated, and a slide valve engine of the saw-mill type of possibly 50 hp. at some point of cut-off. The engine was belted to a counter-shaft which in turn was belted to the dynamo.

The electrical installation included one Brush 16-light and one Brush 6-light dynamo; the sixteen-light machine being the largest that the Brush Electric Company of Cleveland, Ohio, had developed up to the time this station was constructed.

There was no switchboard, but each machine was connected to the outgoing circuit through a single-pole switch and a current indicator erected at any convenient location. There was also a regulator for the generator consisting of carbon resistance blocks adjusted by a solenoid magnet and weight which was supposed to maintain a constant current on the lamp circuit. If, however, the machine circuit contained less than its complement of customers' lamps, the lamps necessary to give the machine its full load were connected in the circuit within the station.

Wiring Arrangements

The lamp circuits were run over the housetops with insulated wire known as "Underwriter's" wire; the insulation consisting chiefly of asbestos paint, supposed to be fireproof and therefore safe. The wire was supported on pony glass insulators and brackets, the latter being nailed to the roof cornices at any convenient place. When all of the customers' lamps were connected to the outgoing wire, the circuit was completed by a connection to the first available water or gas pipe, a similar connection being made from the generator terminal at the station.



This plant, dating from 1880, was built in San Francisco by the California Electric Light Company, predecessor of the Pacific Gas & Electric Company. The picture shows the old type Brush generators, and at the extreme left the early form of switch-board.

The plant operated from dark until 10:30 p.m., exclusive of Sunday, supplying arc lamps in front of stores on Market street and on Kearny street for which the customers paid one dollar per lamp per night—approximately 40 cents per kw-hr.

Street Illumination

Roe, primarily a central station man, was very much interested in street lighting, believing this would ultimately become the chief source of revenue for the company. He expected to establish central station plants in other cities on the Pacific Coast and to secure from them the street lighting contract. The Brush Company of Cleveland had installed arc lamps on a high mast and the "moonlight effect" of lamps at high elevations was much discussed and generally was considered the coming system of street illumination. Roe was desirous of making a demonstration of this high supported, moonlight-effect lamp system, and for this purpose a Brush single-lamp dynamo and a 2000-c.p. arc lamp were shipped to Nevada City. The demonstration was made with the lamp suspended on the dome of court house, and Nevada City was more or less illuminated, but just why a central station and a city lighting contract did not result has been forgotten. It is not recalled that the company had, up to the fall of 1881, placed any apparatus for lighting manufacturing plants or for other commercial lighting, and the writer was sent north to endeavor to light up some of the sawmills on Puget Sound and in British Columbia. Several weeks of effort resulted in selling a 16-light machine and lamps to a mill located on an island near Seattle, and a 5-light outfit to a mill at Berry Inlet in British Columbia.

Price Schedule

The schedule of prices as fixed by the California company was extremely simple; there were three things to sell—generators, lamps, and carbons. There were no discounts, no commissions or resale quotations, and the base price for each item was based on a decimal system, as follows:

Dynamos—per light capacity	$100.00
Lamps—each	100.00
Carbons—per 1000	100.00

All f.o.b. Cleveland, Ohio.

(Continued on page 527)

COMMISSION REGULATION OF ACCOUNTING SYSTEMS

To ascertain to what extent the accounting systems of municipally owned and privately owned public service companies, especially central stations, were controlled by the public service commissions of the various states, the Journal of Electricity sent out the following questionnaire:

Public spirited men have stated that there should be uniformity in the accounts of municipally and privately owned systems, particularly electrical utility companies; that the various state regulatory bodies should be empowered by law to see to it that all central stations within the confines of the commonwealth they serve should have a uniform system of accounting. We believe this to be a fact, and desire to find out to what extent your regulatory body has control of these matters by the following questions:

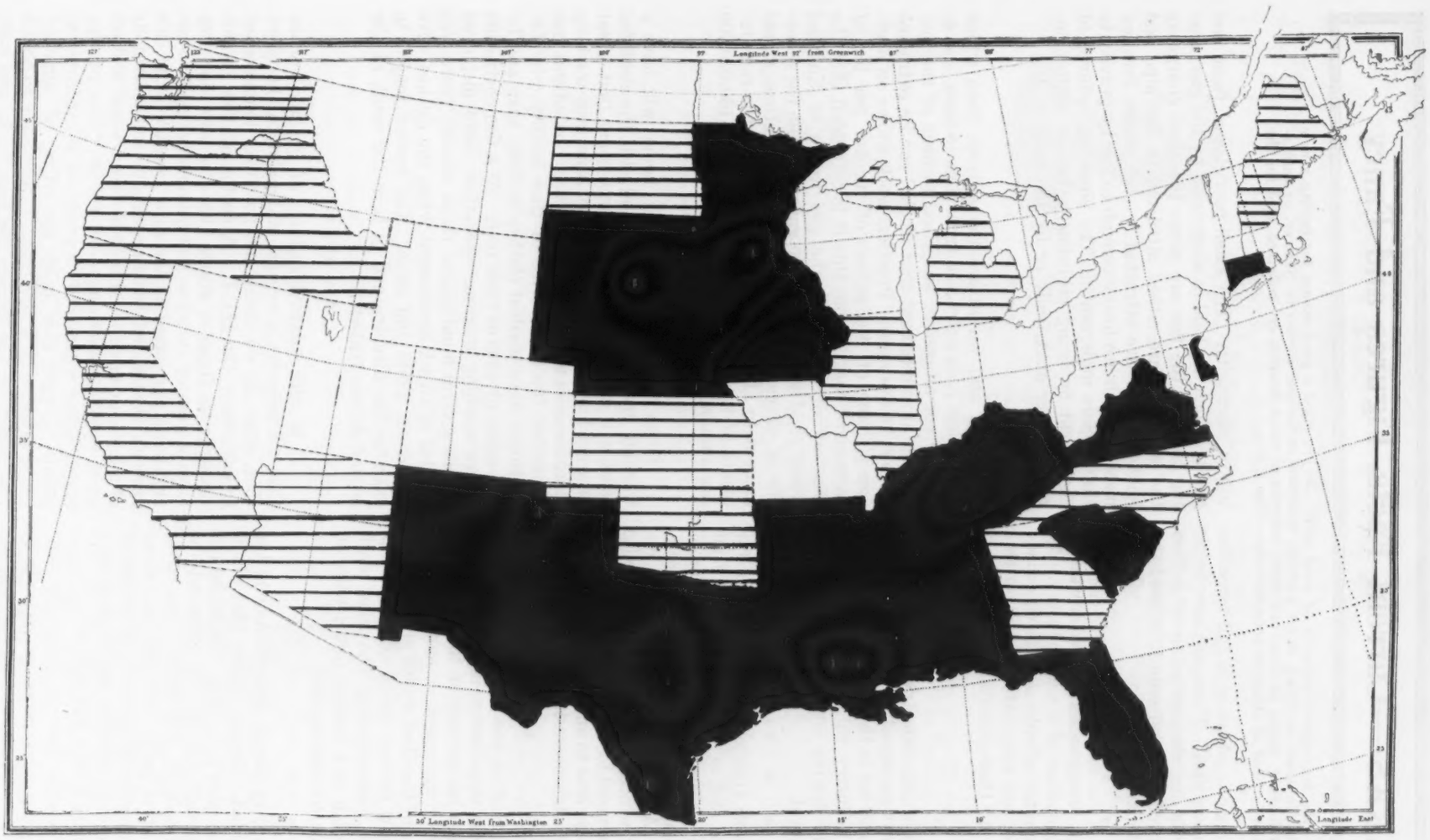
1. Does your commission have the power to control the accounting systems of the central stations in your state?
2. Does your commission have the power to institute a uniform system of accounting for municipally owned as well as privately owned central stations?
3. If not, does your commission believe that such a system of uniform accounts would be fairer to both the companies and to the public?

Results of this questionnaire are here tabulated:

State	Ques. No. 1	Ques. No. 2	Ques. No. 3	Remarks and Authority
Alabama	.....	.....	.....	No state regulation
Arizona	Yes	No	Yes	No state regulation
Alaska	.....	.....	.....	Sec. of Commission
Arkansas	No	No	.....	
California	Yes	No	Yes	E. O. Edgerton, Pres.
Colorado	Yes	Yes	Yes	Sec. of Commission
Connecticut	No	No	Yes	Sec. of Commission
Delaware	.....	.....	.....	No state regulation
Florida	.....	.....	.....	No state regulation
Georgia	Yes	No	Yes	Sec. of Commission
Hawaii	Yes	No	Yes	Wm. T. Carden, Chairman
Idaho	Yes	No	Yes	Sec. of Commission
Illinois	Yes	No	.....	Commission has never considered this question (3d)
Indiana	Yes	Yes	Yes	E. J. Lewis, Commissioner
Iowa	No	No	Yes	Sec. of Commission
Kansas	Yes	No	Yes	Sec. of Commission
Kentucky	No	No	Yes	Sec. of Commission
Louisiana	.....	.....	.....	No state regulation
Maine	Yes	No	Yes	Benj. F. Clemes, Chairman
Maryland	Yes	Yes	Yes	Except for the city of Baltimore. B. F. Fendall, Sec.
Massachusetts	Yes	Yes	Yes	A. R. Weed, Commissioner
Michigan	Yes	No	Yes	William M. Smith, Chair.
Minnesota	.....	.....	.....	No state regulation
Mississippi	.....	.....	.....	No state regulation
Missouri	Yes	Yes	Yes	Sec. of Commission
Montana	Yes	Yes	Yes	W. S. Haynes, Sec.
Nebraska	No	No	Yes	Sec. of Commission.
Nevada	Yes	Yes	Yes	J. F. Shaughnessy, Chair.
New Hampshire	Yes	No	Yes	Wm. T. Gunnison, Sec.
New Jersey	Yes	Yes	Yes	A. N. Barber, Sec.
New Mexico	No	No	Yes	Sec. of Commission
New York—				
Dist. No. 1	Yes	Yes	Yes	James B. Walker, Sec.
Dist. No. 2	Yes	Yes	Yes	Sec. of Commission
North Carolina	Yes	No	.....	Commission has not required this (2) except for reports.
North Dakota	Yes	No	Yes	
Ohio	Yes	Yes	Yes	C. C. Marshall, Chair.
Oklahoma	Yes	No	Yes	W. E. Grimes, Auditor
Oregon	Yes	No	Yes	Ed. Wright, Sec.
Pennsylvania	Yes	Yes	Yes	Sec. of Commission
Porto Rico	Yes	Yes	Yes	F. L. deHostos, Sec.
Rhode Island	Yes	Yes	Yes	Sec. of Commission
South Carolina	No	No	Yes	S. B. Earle, Sec.
South Dakota	.....	.....	.....	No state regulation
Tennessee	.....	.....	.....	No state regulation
Texas	.....	.....	.....	No state regulation
Utah	Yes	Yes	Yes	Sec. of Commission
Vermont	Yes	Yes	Yes	Sec. of Commission
Virginia	No	No	.....	Sec. of Commission
Washington	Yes	No	Yes	J. H. Brown, Sec.
West Virginia	Yes	Yes	Yes	Sec. of Commission
Wisconsin	Yes	Yes	Yes	Sec. of Commission
Wyoming	Yes	Yes	Yes	Sec. of Commission
Manitoba, Canada	Yes	Yes	Yes	A. W. Smith, Sec.
Totals—YES	35	20	39	
NO	12	33	0	

It should be noted that none of the answers to the third question were in the negative, and although some of the commissions neglected to fill out this question it is taken for granted that such an action either means that the commission did not wish to commit itself or that the answer to the second question made an affirmative answer to the third question superfluous.

No broad-minded man will deny that a uniform system of accounts for municipally owned and privately owned public service companies would be fairer to both the companies and to the public. For with different accounting systems there are bound to be different segregations of expenses that will affect materially the earnings of the company. Since the Journal of Electricity has shown the need of such legislation in the majority of the states it is to be hoped that steps will be taken that will insure uniform accounting systems to all public service companies in a state, no distinction being made between municipally owned plants and those owned by private capital.



Here are the results of a nation-wide questionnaire sent out to regulatory bodies of the forty-eight states, from whom unanimous answer has been received. The white portion on the sketch indicates that such states have unified accounting systems under commission control for both privately owned as well as municipally owned utility institutions. The cross hatch indicates that the privately owned utilities are under the direct control of regulatory bodies, with the regulatory body having authority to institute unified accounting systems; while the black indicates that neither privately owned nor publicly owned systems of accounts are unified or standardized under enactment of the state; hence utility companies in such states are absolutely without legal authority for unification of accounting systems. What a powerful impression to the mind it conveys when we see as combined the cross hatched states, and the states in black, existing today without unification of accounting systems for both privately owned as well as municipally owned utility companies. Forceful comment is to be found on this questionnaire by referring to the editorial pages of this issue of the Journal of Electricity.

SPARKS—Current Facts, Figures and Fancy

(What is the horsepower capacity of your will? Do you want a good excuse for buying a new hat? Do you know anything about washing machines in Greece, movies in Norway, or safety-pins in Trinidad? Items on these and other subjects of equal interest are collected here for the reader who is tired of thinking consecutively.—The Editor.)

It seems that Japan is adopting in full force the policy, "It pays to advertise." Plans are now being made to fit up a 10,000-ton steamer as an exhibition place for Japanese products, and send it around the world to advertise Japanese wares.

* * *

The recent war emergencies proved certainly that necessity is the mother of a new industry. Before the war, not an ounce of optical glass was made in the United States, but long before its close this country was producing that material at the rate of twenty tons a month.

* * *

The importance of any industry is measured as much by the amount it consumes as by the amount it produces. It is interesting in this connection to note that the electrical industry in normal times uses from sixty to seventy-five per cent of the entire copper output of the world.

* * *

The most valuable type of power has thus far never been measured and so it is with interest that the scientific world welcomes a recent inention of Professor Sidney Alrutz of the University of Upsals, Sweden. Professor Alrutz asserts that he has devised an instrument which will measure the definite amount of power exercised by the human will. Never before has science been able to announce an invention of such vital and personal interest.

* * *

Motion-picture theaters are being conducted as a municipal enterprise in a Norwegian city. In this community of 100,000 an average of $6.50 for each man, woman and child was spent at motion-picture houses. Nine-tenths of the films shown are of American origin, wild west, mining camp, logging camp, and Alaskan pictures predominating. The other tenth is made up of Swedish and Danish films, with an occasional German or Norwegian film.

* * *

Safety pins are surprisingly popular among the inhabitants of Trinidad. Reports show that about $1000 worth of safety pins are sold on the island per year. Especially remarkable is the demand for safety pins of rolled or solid gold, some of the latter ranging from $1 to $5 in price. Not only are these used widely among women for purposes of ornament as well as utility, but they are also displayed by men in connection with soft collars and scarfs.

* * *

Even the "smoke nuisance" from large industrial plants and smelters is being abated through the use of electricity. The small particles of fume and smoke which are held in suspension by the gas passing through the flue are given the same charge as the wire and are either attracted to the pipe and held there, or are attracted to each other, forming masses which are heavy enough to fall by gravity to the hoppers underneath. The pipes are relieved of their load by being periodically beaten with hammers, either electrically or by the hand.

* * *

Many and varied are the sources from which alcohol has been extracted from time to time, and so we are not altogether surprised to hear of the late British announcement that alcohol can be extracted from coke-oven gas. Practical work shows an average yielding of 1.6 gallons of alcohol per ton of carbonized coal. From this it is estimated that the recovery of alcohol at the gas works of England would yield some 27,000,000 gallons, while the recovery of alcohol and benzol, taken together, would amount to 114,000,000 gallons, to meet the requirements of the country, which amount to 160,000,000 per annum.

* * *

Some day every American home will have a washing machine, of course, and still the field for sales will not be closed. Reports come that great interest has been aroused in the American washing machine even on the Isles of Greece. Its advent has electrified the good wives of that locality who for centuries have washed clothes without soap and by a peculiar process of their own. At a demonstration where washing machine operations were displayed before several hundreds of these women, there was a babel of Greek amazement when the clothes were pulled out white and clean. The women fought to examine the machine and to turn the crank at the second demonstration.

* * *

It is with mingled feelings of joy and sorrow that we welcome a recent statement to the effect that, after all, we should not put forth undue effort to cut down the H.C.L. A doctor of the London Institute of Hygiene states that "a new hat may have a greater curative and stimulative value than any tonic purchased at the drug store." It is this doctor's theory that when mentally and spiritually at a low ebb, one should try the "dress cure" and see what buying something new will do. The psychological effect which will be produced is estimated so highly, in fact, that even the selling of some so-called ornaments is advocated, if necessary to obtain the money for the therapeutic new frocks and hats.

PERSONALS

Frederick G. Cottrell, assistant director of the United States Bureau of Mines, has been nominated by President Wilson as director of the Bureau of Mines to take the place of Dr. Van H. Manning, who has resigned from that position. Dr. Cottrell is well known as an inventor as well as a chemist and metallurgist. He is a Western man, being a native of the city of Oakland and a graduate of the University of California. After receiving degrees as Master of Arts and Doctor of Philosophy at the University of Leipzig, Dr. Cottrell taught chemistry at the University of California, at which time he did considerable research relating to the electrical precipitation of fume and fine particles suspended in the gases of smelter, blast furnace or cement works flues. Here he evolved what is known as the Cottrell process now in world-wide use. Aside from his work on smelter smoke Dr. Cottrell has been deeply interested in and intimately connected with work on the separation and purification of gases by liquification and fractional distillation. During the world war and subsequently thereto the development of the Norton or Bureau of Mines process for the recovery of helium from natural gas has been his special care, and it was chiefly through his efforts that a plant for recovering helium, a rare non-inflammable gas, on a large scale for military aeronautics, has been erected near Petrolia, Texas. Dr. Cottrell is a member of the American Chemical Society, Mining and Metallurgy Society of America, the American Electrochemical Society and the American Institute of Mining and Metallurgical Engineers. He was awarded the Perkin medal by the New York Section of the Society of Chemical Industry in 1919 in recognition of his work on electrical precipitation.

F. E. Newberry, of the F. E. Newberry Electric Company of St. Louis, has been visiting on the Pacific Coast.

O. E. Estoff, vice-president of the H. M. Byllesby Company of Chicago, has been in the West lately on a business trip.

H. C. Rice, manager of the General Incandescent Lamp Company of Cleveland, Ohio, is a recent San Francisco visitor.

G. O. Noble, manager of the Westinghouse Electric & Manufacturing Company, Los Angeles, is a recent San Francisco visitor.

J. J. teKaat of the General Electric Company, with headquarters in Sourabaya, Java, recently passed through San Francisco.

W. H. Onken, Jr., editor of the Electrical World, is spending a short time on the Pacific Coast previous to attending the Pasadena conventions.

C. W. Whitmore, president of the Chamber of Commerce in Buenos Ayres, arrived in San Francisco last week to attend the Foreign Trade Convention.

L. S. Rowe, chief of the Latin-American division of the State Department, has been elected director-general of the Pan-American Union. Dr. Rowe will succeed John Barrett who will retire on the first of September.

T. W. Snell, formerly assistant electric superintendent of the Redwood district of the Pacific Gas & Electric Company, is now with the Coast Valleys Gas & Electric Company as superintendent of construction, with headquarters at Salinas.

A. M. Perry, engineering editor of the Electrical World, is visiting the Pacific Coast after a tour through the Northwest in the interest of Electrical World and the McGraw-Hill Company. Mr. Perry spent some time in San Francisco previous to attending the N. E. L. A. conventions. He is accompanied by his wife and daughter.

J. W. Roberts, of the New York office of the Western Electric Company, is a recent San Francisco visitor. Mr. Roberts is a traveling auditor for the Western Electric Company and is doing work in the West both for that company and for the Northern Electric Company, Ltd. Having already visited southern California, Mr. Roberts plans to go from San Francisco to Seattle and then on through the Vancouver district from where he will return to the New York office.

A. E. Wishon, assistant general manager of the San Joaquin Light & Power Corporation and president of the Pacific Coast Section N. E. L. A., has returned from a trip to the East which he made for the purpose of delivering a number of addresses on his renowned Self-Interest Story. Mr. Wishon spoke before the Eastern leaders of the electrical industry and at every meeting was received with enthusiasm. Mr. Wishon spent a few days in San Francisco previous to his return to Fresno.

J. C. Martin has been appointed Western Editor of the Electrical World with headquarters at Chicago, succeeding Mr. W. H. Spake. Mr. Martin was formerly chief engineer of the Pacific Power and Light Company at Portland, Oregon, and left that position to become chief engineer of the Lehigh Valley Light and Power Company and its subsidiaries at Allentown, Pennsylvania. Mr. Spake will go to New York as assistant to Mr. Lewis of the Business Department of McGraw-Mill Company.

W. L. Goodwin, of the General Electric Company, has come from New York to visit California until the last of July. Mr. Goodwin, who has done more than any other member of the electrical industry in promoting the Electrical Cooperative Campaign, had a significant message to give to the men of the West in his addresses on the Goodwin Plan which he has delivered in San Francisco and Pasadena. During the month of July, Mr. Goodwin plans to spend his vacation in the mountains of California.

D. W. Henderson, who had been superintendent of transportation of the Seattle municipal street car lines since they were purchased by the city in April, 1919, has been appointed General Superintendent of Railways by Mayor Hugh M. Caldwell of Seattle. The appointment has met with universal approval, due in a great measure to the proved fitness of Mr. Henderson for the position. He began his street railway career as a motorman in the employ of the Seattle Electric Company eighteen years ago. Appointed an inspector in 1907, he was appointed to the position of assistant division superintendent of transportation in 1911. He acted as a division superintendent from May until November, 1912, when he was appointed superintendent of transportation. He served in that capacity for the Puget Sound Traction, Light & Power Company of Seattle until the railway lines were purchased by the city in 1919. The present position carries a salary of $5,000 a year.

A. L. Kempster, traction manager of the city of Seattle, has been named general manager of the New Orleans Railway and Light Company to succeed John S. Bleecker who has resigned from that position. The local lines are now in the hands of a receiver, and it will be the new general manager's duty to put them on a solvent basis in as short a time as possible. Mr. Kempster holds a big reputation as a railway man, and it is expected that he will be entrusted with the task of breaking up some of the most serious traffic problems that have ever occurred in any city, one of which is trying to handle 400,000 persons with the same cars that moved 300,000. Previous to his appointment as Seattle traction manager, Mr. Kempster was manager of the Seattle division of the Puget Sound Traction, Light & Power Company. Mr. Kempster will probably return to Seattle when the receiver for the New Orleans street railway is discharged. A year ago he performed a similar service when he was asked to go to Brooklyn in an advisory capacity for the Interborough Rapid Transit Company, returning to Seattle when his work was accomplished. He was invited to look over the situation at New Orleans, and left for there a week ago. Mr. Kempster entered the street railway industry on November 10, 1891, as an office boy with the consolidated street railways of Seattle. He became an accountant, then auditor and secretary of the consolidated, and when the Seattle Eletcric Company was organized, in 1899, he entered the operating department as trainmaster of the system. From there he went to superintendent of transportation, then general superintendent and finally manager. He is married and resides at 515 Twenty-second Avenue North, Seattle.

H. H. Randall, of the Capital Electric Company of Salt Lake City, visited San Francisco recently.

Floyd Averill, Fobes Supply Company, Portland, Oregon, spent a few days in San Francisco on business recently.

C. R. Hennerick, Western Electric Company, has been transferred from Atlanta, Georgia, to the San Francisco offices of the company.

A. S. Lindstrom, of San Francisco, has been appointed as one of the four new agents and representatives for the Greaves-Etchells Flectric Furnace Construction Company.

J. O. Case, sales manager for the Los Angeles district of the General Electric Company, recently made an extended trip in the East, where he visited all the important offices and factories of his company.

L. E. Newberry of the Newberry Company, prominent contractor-dealers of Chicago, St. Louis, San Francisco and Los Angeles, who usually has his headquarters in Chicago, Illinois, is a recent Pacific Coast visitor.

Edward Woodbury, until recently electrical fabrication engineer of the American International Shipbuilding Corporation at Hog Island, has been transferred to the Pacific Coast where he will be in charge of the field work, installing the electrical equipment at the new Caribou plant of the Great Western Power Company which is being constructed by Stone and Webster.

J. A. Vandegrift, general sales manager for the Pacific Coast of the National Lamp Works, has just completed a trip to the principal business cities of the West together with **M. G. McKitterick**, general sales manager, **Paul F. Bauder**, sales manager of the Miniature Lamp Department, and **P. B. Zimmerman**, manager of the publicity department of the National Lamp Works. He has held conferences with National "B" agents in Seattle, Portland, San Francisco and Los Angeles.

Samuel A. Chase, Westinghouse Electric and Manufacturing Company and **Harry Kirkland**, General Electric Company, were two of the principal speakers at the "get together" dinner of the California Electrical Cooperative Campaign held in the Commercial Club at San Francisco on the fifth of May. In company with W. L. Goodwin, Mr. Chase and Mr. Kirkland have been speaking in the large electrical centers on their way to the N. E. L. A. Convention.

R. M. Woolley, of the United States Geologic Survey, has been compiling data on the unexploited power resources in the Great Salt Lake Basin. Mr. Woolley reports that at present there are fifty power plants in the basin generating 160,000 horsepower. He has made the recommendation that the 145,000 horsepower now going to waste be utilized.

M. T. Crawford, superintendent of distribution, Puget Sound Power & Light Company, Seattle, has returned from a six weeks' tour through the larger centers of the East and South, studying underground transmission, both d.c. and a.c.

J. B. Campbell, of Springfield, Illinois, has purchased the power plant and business of the Morton Electric Company of Morton, Washington, from **C. S. Hagerty**, formerly of Tacoma. The plant is situated on the Tilton river about one mile west of the town. Mr. Campbell intends installing an electrical supply store in connection with the business.

J. P. Lottridge, general manager of the Eastern Oregon Light & Power Company, which serves both Baker and Union counties, returned Thursday from Milwaukee and Chicago, where he had a most satisfactory conference with the directors and bankers interested in his company. At the meeting it was decided to erect a steam plant at La Grande which will cost approximately $200,000, and before returning home Mr. Lottridge made all arrangements for machinery equipment. He also arranged for an improvement of the gas plant in Baker and the machinery was purchased, some of it now being on the way to that city.

Carl H. Reeves has been appointed superintendent of public utilities by Mayor Caldwell of Seattle, succeeding Thomas F. Murphine. Major Reeves has been a resident of Seattle for the past twenty-seven years and has long been engaged in engineering work in connection with the street railways, and on construction of city utilities. He served in the office of the city engineer for several years prior to 1906, and while serving in that capacity, designed much of the city's sewer system and other municipal projects. From 1906 to 1916 he was assistant engineer with the Seattle Electric Company, resigning in 1915 to perform special work for the State Public Service Commission, after which he took up private practice. He was the first engineer officer called from Seattle to active duty assignment in the Engineer Corps, directing engineering work at Camp Fremont, California at Puget Sound forts, Camp A. A. Humphreys, and other camps throughout the country. After serving 23 months he was discharged as a major, June 4, 1919.

OBITUARY

Henry Dorr, manager of the Garden City Electric Company of San Jose, and a member of the executive committee of the California State Association of Electrical Contractors and Dealers, died suddenly at his home in San Jose a short time ago.

Meeting Notices for Electrical Men

(A record-breaking meeting of the California Cooperative Campaign, addressed by the leaders of the cooperative plan in the electrical industry, is recorded here along with a complete report of the Visalia meeting of the California Association of Electrical Contractors and Dealers, and notices of A. I. E. E. and Contractor-Dealer activities in the Northwest and Utah.—The Editor.)

California Cooperative Campaign Dinner

When W. H. Goodwin stood up to speak at the dinner of the California Electrical Cooperative Campaign at the Commercial Club in San Francisco on the evening of May 5th, the three hundred and fifty contractor-dealers, jobbers, manufacturers agents and central station men who had gathered there to greet "Bill" and listen to his message of proper methods of merchandising, stood on their feet and cheered him long and loud. Lee H. Newbert, chairman of the advisory committee of the campaign was toastmaster and prior to the speech of Mr. Goodwin introduced the other speakers on the program.

A. Emory Wishon, president Pacific Coast Section N. E. L. A., the first speaker of the evening, spoke of his trip east and once more brought home to the men of the electrical industry of the West the importance of their preaching the "self interest story" to the men of the East when they meet them at the Convention at Pasadena on the twenty-first of this month.

Harry Kirkland, of the General Electric Company, was the next speaker and told of the need of better merchandising methods on the part of the electrical dealer. Mr. Kirkland presented a series of interesting figures showing the activities of the manufacturers during the present year, some of these figures showing enormous increases in production. The summary of the activities might be illustrated by the fact that there will be 14,030,000 attachment plugs and snap switches manufactured in 1920.

Samuel A. Chase of the Westinghouse company was then introduced and spoke of the spread of the cooperative movement through the East and the results obtained by the spread of this gospel of "live and help live" where the contractors, dealers, manufacturers, jobbers and central station men were all speaking a common language of cooperative competition instead of destructive competition.

"Merchandising," was the subject of the talk given by Mr. Goodwin and in his usual convincing manner he told the contractor-dealer that while California is practically the leading state in cooperative movements, the one thing the electrical industry needs is capital that will enable the central station to extend their lines. Mr. Goodwin went on to point out that in competition with the ten per cent return offered by real estate the little eight per cent offered by the central station would not attract the man who had money to invest but that it was necessary for the electrical men to show their belief in their industry by investing in central station bonds and stocks. In pointing out the road to better merchandising methods Mr. Goodwin urged the use of the trade journals, the use of liberal and intelligent advertising, and modern methods of salesmanship. The store was discussed next, including its location, appearance inside and outside and the proper use of the windows for the display of goods. The talk was full of excellent ideas that went home as each man present saw the weak points in his own organization and the remedy for them.

The San Francisco Electrical Contractors and Dealers had a large table to themselves as did the East Bay Association and during the dinner each group tried to outdo the other by different stunts. The music was furnished by a jazz orchestra that played all of the familiar songs and the members joining in and singing between courses.

BUILDERS OF THE WEST — LXXVII

E. O. EDGERTON

Today no one has greater opportunity for service than those who have it within their power to establish just and reasonable rates and returns for utility companies throughout the nation. The country as a whole owes a deep debt of gratitude to men of vision who have been able to sense the possibility of good to the public, and progress to the nation, in the awakening of the highest ideals of service, and in setting up at the same time reasonable rewards for sincere effort put forth. E. O. Edgerton, President of the California Railroad Commission, is today awakening in the hearts of his fellow citizens new and healthy ideals for progress and service to the public, and to him this issue of the Journal of Electricity is affectionately dedicated as a lasting memorial to the magnificent work he is accomplishing.

Montana Contractors and Dealers Form Association

The electrical contractors and dealers of Montana held a meeting in Butte on April 24th and 25th to form an Association which will be known as the Electrical Contractors and Dealers Association of Montana. Constitution and by-laws were adopted and many other business matters attended to during the Convention. Application has been made by the Association to become affiliated with the National Association of Electrical Contractors and Dealers. Mr. J. C. Curran of Helena was elected President and E. Downing Secretary and Treasurer of the Association. An executive board was also elected which consists of Joseph Olson of Great Falls, Carl Miller of Kalispell, O. C. Langstadt of Butte, and A. A. Nicholas of Billings. The next meeting of the organization will be held in Great Falls in October of this year.

Seattle Section, American Institute of Electrical Engineers

The regular monthly meeting of the Seattle Section of the American Institute of Electrical Engineers held on April 20th, was of unusual interest. Three papers were read before the Section. One of the papers was entitled, "New Features of the Cedar Falls Pipe Line," by Mr. F. R. Nicholas, Locating Engineer for the Seattle Municipal Lighting Department, W. J. McKean, Engineer of Construction, Seattle Lighting Dept., spoke on "New Features of Power House Design," and the third paper by Mr. Glenn H. Smith, Engineer of Outside Construction of the Seattle Municipal Lighting Department, was "A New Plan of Distribution."

The three speakers discussed the special features that are being embodied in the construction work now under

way or contemplated in the immediate future by the Lighting Department of the City of Seattle. Some of the ideas involved radical changes in regard to engineering, and were of unusual interest, causing considerable discussion of the papers.

At the May meeting of the Section Mr. H. J. Shepard, District Plant Engineer of the Pacific Telephone and Telegraph Company, will present a paper on "Methods Used in Laying Submarine Cables." This paper will be illustrated by slides and will set forth methods used by Mr. Shepard in laying long submarine cables of large diameter.

Visalia Meeting of California Association Contractors and Dealers

The regular meeting of the California State Association of Electrical Contractors and Dealers was held in Visalia on Saturday, April 24th. In the morning the executive committee held their meeting, the principal business being the consideration of twenty-nine applications for membership in the state association and the acceptance of the resignation of one of the members who had gone out of the business of electrical contracting. A letter was received from the Oregon Association of Electrical Contractors and Dealers in which they announced that there would be representatives from their association at the N. E. L. A. convention at Pasadena on May 21st. They further accepted the invitation of

Group of members and visitors at the Visalia meeting of the California State Association of Electrical Contractors and Dealers. The picture was taken in front of the Visalia Municipal Auditorium where the meeting was held.

the California Association to be present at its monthly meeting there on May 18th. A temporary assistant to the state secretary was appointed to act in the Southern California division.

New Section Formed

Two new sections were formed, Santa Barbara and San Luis Obispo, Mr. S. Bretherton being appointed to act as executive committeeman from the latter section. A letter was also received from the Vancouver, B. C. Association of Electrical Contractors and Dealers stating that they would be represented at the N. E. L. A. convention at Pasadena, and the May meeting of the California Electrical Contractors and Dealers and that while they had a real live cooperative campaign in their territory, they nevertheless wanted to get the California idea of the campaign and see if there were not some points that could be introduced in the Northwest that would increase the efficiency of their efforts.

Motor Section

At the meeting of the motor section presided over by J. A. Woods, of the California Mechanical and Electrical Engineering Company of Sacramento, the principal business was a letter from the Electrical Railway and Manufacturers Supply Company which contained drawings to be used as a help to the contractors from small towns, in making motor installations. This letter was referred to the motor standardization committee, following a discussion of the standardization of wiring for motor installations. There being no further business the meeting was adjourned and the next meeting set for the 18th of May at Pasadena.

Retail Section

The meeting of the retail section was presided over by Louis Levy of the Levy Electric Company of San Francisco, with J. M. Gregory, secretary of the East Bay Electrical Trades Association acting as secretary. There were several speakers on the subject of advertising including H. W. Angus, secretary of the California Cooperative Campaign and James E. Baker of Bakersfield. Mr. R. D. de Journett, of M. C. Baker and Son, San Francisco, started a discussion on the best type of window display in which a great number of the members took part and told of the schemes that they had adopted in advertising their merchandise through window displays.

General Session

At the general session, the minutes of the executive session were read by secretary James W. Redpath, announcement being made of the new members and the formation of the two new sections.

Reports were received and accepted from the motor and retail sections and Mr. E. E. Brown of the standardization committee reported on the estimate sheets. No decision was reached and the members who had estimate sheets of their own were asked to send the name to Mr. Brown who would then prepare sheets to be posted at the next meeting where all of the members could have an opportunity to look them over before voting on the official form to be adopted by the association, which form would be accepted as official by the state association.

Mr. C. F. Butte was appointed to represent the State Association on the Executive Committee of the Pacific Coast Section N. E. L. A.. The next meeting of the association was set for May 18th at Pasadena, and the June meeting to be held in San Jose on the 19th.

After a Spanish dinner full of pepper, literally and figuratively, which had been arranged by H. H. Courtright, Valley Electrical Supply Company, of Fresno, a meeting of the association was held at which Mr. L. H. Newbert, chairman of the advisory committee of the California Cooperative Campaign spoke on the "Relation of the Central Station to the Contractor-Dealer." In his talk Mr. Newbert brought out the fact that the contractor-dealer was able to help out the central station man especially in the matter of complaints. It is possible by this kind of cooperation for the dealer to secure greater benefits from the campaign and he will find that the central station is only too willing to do all that it can to reciprocate.

Mr. R. M. Alvord, a member of the advisory committee of the Cooperative Campaign, spoke on "Better Service," pointing out that better service means better business and that all of the suggestions made by the campaign always meant better service. He showed that in bringing the dealer out of the alley to the main business stem, urging more courtesy in salesmanship, and the acceptance of the standard accounting system, in teaching the contractor modern methods in window display and by the convenience outlet campaign, the California Cooperative Campaign is merely teaching the meaning of better service.

All of the meetings were well attended and there were over one hundred members of the association present with a large representation of central station men, jobbers and manufacturers who are following the meetings of the contractor-dealers with a great deal of interest.

Cooperative Convention—Vancouver

The Vancouver Association of Electrical Contractors and Dealers will hold its convention May 31st and June 1st. This association sends out an invitation to contractors, dealers, manufacturers, central station men and jobbers of the Pacific Coast to attend the convention. W. L. Goodwin, Samuel Adams Chase and Harry Kirkland will be at this convention and will address the meeting on various subjects which relate to cooperation.

The association secretary announces that Vancouver hotels are full and asks those who wish to attend the convention to secure accommodations early by writing.

Utah Electrical Dealers Gather

Members of the Utah Society of Electrical Contractors and Dealers listened to an address by Harry B. Kirkland, of the General Electric Company, New York, on the evening of May 3rd at the Commercial Club. The title of the address was, "A Two-Billion Dollar Business." Samuel Adams Chase, Westinghouse Electric & Manufacturing Company, of Pittsburgh, Pa., gave an address on "Results Obtained Through Adopting the 'Goodwin Plan.'"

Mr. Chase advocated the slogan of "Live and help live," instead of "Let and let live," as well as the slogan, "Cooperative competition" instead of "Destructive competition."

William Lincoln Goodwin of the General Electric Company of Schenectady, N. Y., then addressed the gathering, giving a general talk on all problems of interest to all classes in the electrical industry and on scientific merchandising. He spoke on "Charting the Course for the Electrical Industry," illustrating this portion of his address with descriptive charts. He also described the "Goodwin Plan" of scientific merchandising, of which he is the originator.

Following the addresses of the speakers, who were introduced by George R. Randall, president of the Salt Lake organization, lunch was served by courtesy of the general Salt Lake jobbers.

Everett Contractors Organize

Members of the Electrical Contractors and Dealers' Association of Snohomish county, Washington, met at Everett recently and adopted a constitution and by-laws. A committee composed of T. H. Erickson, chairman, S. O. Patterson and S. A. McCutcheon was chosen to meet with the committee from the electricians' union to discuss the proposed wage scale advance that became effective May 1. City Electrician Fred Rosco met with the association recently and took up with it the question of cooperation in the matter of securing a better quality of work in new construction jobs.

(Continued from page 520)

Neatly printed sheets of estimates of the cost of complete plants and cost of operation for possible central station installations, based upon the above prices for the electrical machines, were also used. These estimates were for plants ranging from 5 to 100-lamp capacity and it was shown very conclusively by them that a station of any size between these limits could be constructed and would pay dividends of from 20 to 40 per cent on the investment.

First Central Station for Municipal Lighting

The first central station on the coast designed to supply street lighting to a municipality was constructed at San Jose in 1881-1882. It was modeled after the O'Farrell Street station but was somewhat larger. About this time, and in connection with the Cleveland mast lighting system, the Brush Company had produced a dynamo to supply lamps of 4000-candle power each. There was no doubt in the minds of the manufacturers about this quantity of light because it was shown that the current generated was twice as great as in the 2000-c.p. lamp machine, and also that the lamps had carbons that were twice the area of those used in the 2,000-c.p. lamps, hence the candle power rating of the new combination must be 4,000 c.p. One of these machines supplying five such lamps was installed in the San Jose station. During the station construction period, largely through the efforts of Editor Owen of the San Jose Mercury, citizens had contributed funds for the construction of a tower to support these high candle power lamps, from which the "moonlight effect" was to illuminate the city.

The San Jose station had two tubular boilers and a slide valve engine, countershaft, and so forth, all similar to the O'Farrell Street equipment, but in addition to the tower-lighting dynamo, contained a Brush 40-light machine which had been recently developed. This machine furnished current to the mast-arm lamps for street lighting and to the lamps of a few commercial customers.

The tower, located at the intersection of Market and Santa Clara streets, was constructed of pipe, had a base spread of about 75 feet, and narrowed to about 5 feet at an elevation of 200 feet. There was an umbrella-shaped reflector at the top and underneath it the five lamps of 4,000 c.p. each (20,000 c.p.) were suspended.

It was expected that the entire city would be lighted with an intensity equal to full moonlight, and while the general effect in the outskirts was good, the vicinity of the tower, for a radius of several blocks, was almost totally dark.

To overcome this area of darkness, the writer designed a corner mast-arm lamp support to place a single lamp over the center of the intersecting streets. This arm arrangement was probably the first of its kind. It consisted of a pole top casting which supported extending pipes 16 feet long; a wire rope truss member helped to maintain the horizontal pipes in position and to support the lamp. Ropes running through the horizontal pipes, over pulleys on the pole top casting, served to lower the lamp for trimming, the connection with the circuit being made automatically when the lamp was hoisted to its position. Sixteen or eighteen of these mast-arm lights were necessary to dispel the gloom around the tower.

Plant Expansion

In 1881 and 1882 the San Francisco station at O'Farrell Street became too small and a new, larger and more modern station was built south of Market Street. Other lighting systems were coming from the East—Edison, Weston and others, including the "divided" arc, as the incandescent lamp was sometimes called.

The great hydroelectric plants of the Pacific Coast of today show the progress of the industry for the 40 years that have elapsed since the O'Farrell Street station 16-light, 1000-volt dynamo supplied its customers' lamps over a roof-top circuit on a single wire and a gas-pipe return.

Western Men of the N. E. L. A.

R. H. BALLARD

Vice-president and general manager of the Southern California Edison Company, and president of the National Electric Light Association.

It is fitting at this time that the entire electrical industry should express to Mr. Ballard its appreciation of his wonderful and untiring work as president of the National Electric Light Association. To his energy and vision is due in large measure the progress and cooperation which the past year has seen in the organization, and the enthusiasm which characterizes the great convention now gathered in the West.

E. O. EDGERTON

Mr. Edgerton, president of the California Railroad Commission, in which service he has been for the past six years, is a great power in the formulation of progressive thought on the subject of public utility regulation. Because of his attitude the utilities of California are now enjoying a condition of healthfulness which is being reflected throughout the West.

F. M. KERR

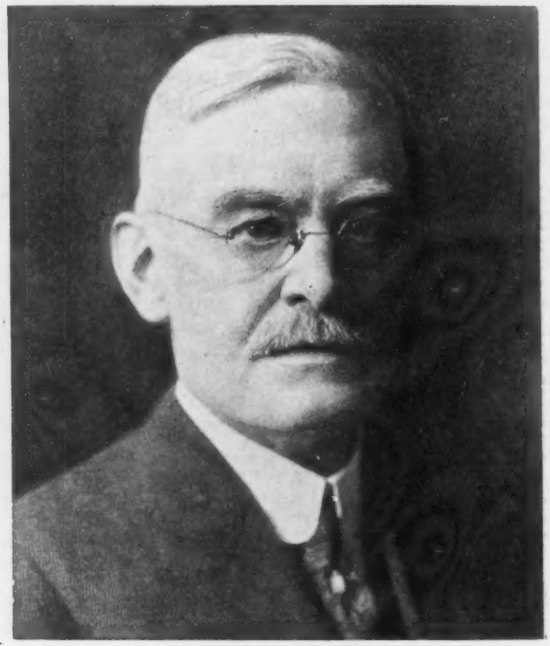
Mr. Kerr, vice-president and general manager of the Montana Power Company, who as chairman of the Railroad Electrification Committee will deliver the report of that committee, has come into close touch with the central station viewpoint of this problem through his interests in the Montana company which supplies a large share of the power for the electrification of the Milwaukee Railroad.

F. T. GRIFFITH

Mr. Griffith, president of the Portland Railway, Light & Power Company, will present to the convention the report of the Water Power Development Committee of which he is chairman. It is thought that this report will stand for years as the authoritative compendium of the legal and physical facts relating to this subject which is of such supreme importance to the West.

S. M. KENNEDY

Mr. Kennedy, vice-president and general agent of the Southern California Edison Company, has achieved such a pre-eminent position in the sphere of relations between the central station and its customers that he is thoroughly qualified to deliver his individual report on "Service" at this convention, as a guide to the highest type of practical idealism in public service.



JOHN A. BRITTON

Vice-president and general manager of the Pacific Gas & Electric Company, and chairman of the Public Policy Committee of the National Electric Light Association.

Few names are better known to the electrical industry throughout the nation than that of John A. Britton. As chairman of the Public Policy Committee of the National Electric Light Association he has applied to the affairs of the organization that sound judgment and clear-sightedness which have won for him the respect and admiration of all who have worked with him.

J. B. FISKEN

Mr. Fisken, chief consulting engineer of the Washington Water Power Company, will be the leading delegate from the Northwest to interpret to the convention the ideas and ideals of the Northwest Electric Light and Power Association. He has held the position of president of that association during the past year.

J. B. MILLER

Mr. Miller, chairman of the board and president of the Southern California Edison Company, who is acting as Convention Chairman, has exercised his unique ability so to organize his forces that results are accomplished without seeming effort, that this convention may pass into history as one of the most efficiently conducted ever recorded by the organization.

L. H. NEWBERT

Mr. Newbert, commercial manager of the Pacific Gas & Electric Company, will tell the convention of the development of the California Electrical Cooperative Campaign. As chairman of the Campaign committee Mr. Newbert has led in the movement to establish more firmly the use of electrical equipment in the home. This California idea has now spread over the whole country.

A. E. WISHON

Mr. Wishon, assistant general manager of the San Joaquin Light & Power Corporation, has just closed the most successful year of the Pacific Coast Section of the National Electric Light Association under his guidance as president. In addition to this accomplishment he has won national distinction in the extension throughout the country of his able "Self-Interest" appeal.

HAPPENINGS IN THE INDUSTRY

FINAL RATE DETERMINATION

Pending the final determination of the rates and charges to be collected by the Southern Sierras Power Company, the company will be allowed to collect from its consumers in the city of San Bernardino the same schedule of rates collected by the Southern California Edison Company, its competitor. The lighting rates of both companies were identical up to April 15th, when the Commission authorized the Edison company temporarily to increase its rates by 27%. Today's order was issued on application of the Sierras company, which has pending an application for a revision of its rates. The Commission says:

"For very substantial reasons the rates of these two companies, where they are in competition, should remain the same. A marked difference in rates, such as would result if this application be not granted, would cause a transfer of business from the high to the low rate company, thus imposing a burden resulting in a denial or breakdown of service. From every standpoint it is better that the rates of these two companies be kept on a parity in competitive territory, at least until final rate schedules are established."

INCREASED COST OF CONSTRUCTION

An increase of approximately twenty per cent in the cost of labor and material, unexpected and unforeseen construction difficulties and a change in the power house plans are given by the Great Western Power Company of California as reasons for a stock issue of $1,500,000 asked for in an application filed with the Railroad Commission. The company says that it will need the money raised through the proposed sale of its preferred stock to complete the Caribou plant on the north fork of the Feather River in Plumas county. According to the company's application the plant will cost $1,924,670 more than the original estimate.

SOUTHERN CALIFORNIA EDISON'S CONSTRUCTION BUDGET

The Railroad Commission has authorized the Southern California Edison Company to issue and sell $5,000,000 of its general and refunding mortgage six per cent 25-year gold bonds. In an exhibit filed with the company's application for authority to make the bond issue it was shown that the company plans to expend from March 1, 1920, to December 31, 1920, $8,505,000 to carry on hydroelectric development work and construct necessary transmission and distribution lines. Funds derived from the sale of the bonds are to be deposited in a special fund and expended only for such purposes as the Commission may authorize.

Among the proposed expenditures for development work are the following:

To complete Kern River No. 3 development	$1,985,000
To carry on work at Big Creek including third unit at Big Creek No. 2, work on Shaver tunnel and reservoir, Pitman Creek tunnel and on Big Creek No. 8	2,108,000
To complete substation at Vestal (Richgrove)	814,000
To complete Greenhorn transmission line from Kern No. 3 to Vestal substation	531,000
To complete change at Eagle Rock for increasing the capacity of that substation	312,000
To install additional steam turbine at Long Beach	420,000
To pay for necessary changes and increases in general transmission and distribution system	2,335,000
Total	$8,505,000

RATES INCREASED

Because the cost of the power it buys from the Southern California Edison Company has been increased twenty-five per cent by a recent decision of the Railroad Commission, the Ontario Power Company, operating in Ontario, San Bernardino, county and vicinity, was today authorized by the Commission to increase its rate charged for optional irrigation pumping to a price which will produce sufficient revenue to offset the increased cost. Continuation of the present rates would mean the sale of power at a rate less than its cost. The increase is temporary, as is the increase granted the Edison Company; the new rates are being collected for all regular meter readings taken on and after April 25th.

NEW N. E. L. A. GEOGRAPHIC SECTION

Tentative plans for the organization of a Great Lakes geographic section of the N. E. L. A. were made at a conference in Chicago a short time ago. The conference was attended by the following:

For the Illinois State Electrical Association: B. J. Denman, president (president Tri-City Light and Power Company,, Davenport, Iowa; E. V. Prather, secretary, Springfield, Illinois. For the Indiana Electric Light Association: Phil. H. Dwyer, president (assistant treasurer and manager, Indiana Railways and Light Company), Kokomo, Indiana; Thos. Donohue, secretary (local manager, Northern Indiana Gas and Electric Company), Lafayette, Indiana. For the Wisconsin Electric Association, N. E. L. A.: W. C. Lounsbury, president (general manager, Superior Water, Light and Power Company), Superior, Wisconsin; J. P. Pulliam, secretary for the Michigan section, Milwaukee, Wisconsin; W. N. Lewis, president (district manager, Consumers Power Company), Muskegon, Michigan; Herbert Silvester, secretary (Eastern Michigan Edison Company), Ann Arbor, Michigan; and Martin J. Insull, of the Middle West Utilities Company, Chicago, Illinois.

COPY FOR N. E. L. A. BULLETIN

In order that the N. E. L. A. Bulletin may be kept both pointed and newsy, the following question and suggestion are being sent to company officials from the Bulletin office:

Has your company had recent changes in organization, ownership, control, or rates; staff promotions; plant expansion; meetings or organizing of employes' clubs; or other happenings of interest to the industry? If member executives will ask themselves: "Would I want to read this news if I were in another company in another part of the country," it is believed that they will submit the kind of copy we want for the Bulletin.

Some of the strongest N. E. L. A. company sections send in splendid material, but nevertheless it is felt that many central stations not represented by company sections could contribute more than they have been offering. This is particularly true of the small companies, whose strength and progress are essential to the welfare of the central station industry as a whole, and whose work is often unchronicled.

Further instructions are also given to the effect that news should be reported as quickly as possible. Forms close the 15th of the month preceding cover date, though it is often possible to find a place in the Bulletin for material received a few days later.

EMORY WISHON'S EASTERN VISIT

In addition to putting over one of the most strenuous as well as successful speaking tours ever undertaken in the East in behalf of hyhroelectric development of the West, Emory Wishon, assistant general manager of the San Joaquin Light and Power Corporation, and president of the Pacific Coast Section, N. E. L. A., has found time to look into affairs of the National Association and pass forceful and helpful comment as indicated in the following letter to R. H. Ballard, President of the National Electric Light Association:

"I spent the morniing with Mr. Aylesworth going over a great number of matters with him, and discussing the Geographic Section idea with him from all angles. This is just to congratulate you on the man you selected. He is the kind of a man the association has been needing for a long time, and I am of the opinion that he will keep things moving for the good of the association from now on. Have another date with him on Tuesday. Hope everything is going well on the Coast.

Very truly

A. EMORY WISHON.

CONTRACT LET FOR HETCH HETCHY TUNNELS

The contract for the fully lined tunnels on the Hetch Hetchy project has been awarded to the Construction Company of North America on the cost-plus basis. The contractor will be paid in Hetch Hetchy bonds at par and he guarantees that the cost of the entire work will not exceed $7,802,953.80, which includes his fee of $1,190,000. The city engineer will retain supervision of all the work. The approximate difference in the price of the accepted contract and the bid on the unit plan of the R. C. Storrie Company was

$2,000,000. The cost-plus plan has been pronounced legal by the city attorney and the special counsel of the Hetch Hetchy project, and while there have been injunction suits threatened on the claim that the cost-plus contract is in opposition to the city charter the work will be started at once by the contractors. The immediate sale of $8,000,000 of Hetch Hetchy water bonds was voted by the Supervisors at the same time to carry out the contract. While the contract is for three years' work necessary to complete the mountain division of the project, there is a provision that it can be terminated at the end of one year, either by the city or by the contractors.

COMPANY CHANGES NAME

The name of the Puget Sound Traction Light & Power Company has been changed to the Puget Sound Power and Light Company. Since the sale of the Seattle street railway lines operated by the old company, it has been concentrating on power and light business, hence the change of name. The reason, however, is fully set forth in the following statement by A. W. Leouard, president of the Company:

"The company does an electric light and power business in 142 communities in the Puget Sound Basin, the territory covered extending from the Canadian border at Sumas to Olympia. Increased power demand compels the company to concentrate its energies on power and light lines. This is due to the electricfication of industry and to the larger use of electricity in the homes. On top of the growing demand for this form of energy in industry and the increased use of electrical appliances in the homes is coming the electrification of railroads. One of the very largest single power customers in the Northwest now is the Chicago, Milwaukee & St. Paul Railroad.

"The Puget Sound Power & Light Company has hydro-electric plants at Electron on the Puyallup river, at Snoqualmie Falls, on the North fork of the Nooksack in the Bellingham district.

"The combined plants have a capacity of 114,700 horsepower hydro-electric, in the Tacoma-Seattle-Everett district and besides there is a steam plant of 40,000 horsepower. Thus the total capacity in the Tacoma-Seattle Everett district is approximately 154,000 horse power and the combined capacity of the two districts is about 167,000 horsepower. In addition the company owns several valuable but as yet undeveloped hydro-electric sites and has sufficient storage at Lake Tapps to further increase the capacity of the White River plant.

"It will be the purpose of the new Puget Sound Power & Light Company to give its undivided attention to the development of power and light to the encouragement of industry requiring cheap and economical hydro-electric energy.

"There will be a practically unlimited supply of such energy always available in this region. In supplying the demand of the Milwaukee for operation of the Coast division of its transcontinental lines the plants of the company have been interconnected with generating and transmission lines and a combined generating capacity of more than 300,000 horsepower.

"Construction of a 30-mile link between Everett and Mount Vernon will bring this interconnected system into connection with the Bellingham District and the systems of Southwest British Columbia, thus adding another 135,000 horsepower, or a total of 435,000 horsepower available over a very wide territory to carry the industrial load of the region.

"Possible increased development of other available power sites would double that capacity without going upon the public domain for any additional hydroelectric resources."

CHANGES IN THE NATIONAL ELECTRICAL CODE

At the recent public hearing with regard to recommended changes in the National Electrical Code, the limit of low potential systems was fixed at 600 volts instead of 750 volts as recommended in various sections of the Bulletin discussed at the meeting.

The proposal to require polarity identification in all wires installed on and after January 1st, 1921, was modified to require that beginning July 1st, 1921, twin wires for conduit work and twisted pair wires for armored cable in sizes Nos. 12 and 14 B and S Gauge provide the means for continuous identification proposed in the bulletin for rule 26a. Rule 77 on fixtures to be revised to require identification marketing by the fixture manufacturers of the wire connected to the screw shells of socket.

A committee is to be appointed to consider requirements for the installation of concealed extensions from existing wiring in buildings of fire-resistive construction.

Reports of the following committees were considered and adopted substantially the same as printed in the Bulletin.

Committee on Cars and Railways; Devices and Materials; Outside Wiring, Building Supply and Services; Theatres, Motion Pictures, Places of Public Assemby and Garages; Reconciling the National Electrical Code and the National Electrical Safety Code.

In the report of the committee on Fixtures, Heaters, Signs and Lamps—under the section on Fixtures—Rule 30a was made to read:

Insulating joints may be omitted in the case of straight electric fixtures installed on grounded race ways when the grounded wire of the circuit is connected to the screw shell and when approved fixture wire is used.

The report of the committee on Generating and Substations was adopted as printed but in addition the committee was asked to consider amendments to Rule 1d to exclude from its application, equipments of public utilities.

The report of the Section on Overload Protection of Motors under the committee on Industrial Applications was referred back with power to the committee for conference with industries interested. The report on the subject of Size and Protection of Conductors of Motor Circuits was also referred to the committe with power and instructions to continue the last paragraph of present rule 8c. The recommendations under the head of Motor Switches were approved, but the report was referred back to the committee with power for rewording after consideration of the problem of large switches. Under the section, Motor Switches—Enclosed Type, the recommendation made to require the externally operated enclosed type of switch for motor circuits was not adopted.

Under the report of the committee on Signaling Systems, the supplementary report on radio equipment was adopted, but with changes in minor details as to equipment. The committee was requested to consider the use of resistance devices instead of spark gaps.

The report of the committee on Wiring Standards and systems, conduit work, sizes of wire, etc., was adopted as it stood except for the recommendations under the section on Wattage Limits for Branch Lighting Circuits where the recommendation not to require special permission for 1320 watts on circuits with medium base sockets was not adopted.

The recommendation to change 1320 watts to 1500 watts was not adopted, and where provision was made for circuits up to 4000 watts when Mogul sockets are used special permission will be required.

Under rule 34 circuits of 4000 watts will be permitted by special permission.

The wording of the 1918 Code is to be continued, except for the addition of the last sentence in proposed Rule 26j as printed in the Bulletin and except for the recognition of Varnished Cloth Insulation.

The recommendations as printed in the Bulletin under the heading, Low Voltage Lighting Systems were referred back to the committee with power for editing.

FARMERS ASKED TO CO-OPERATE

An effort to secure the cooperation of the farmers in the fight to overcome the power shortage is being made by all of the farm bureaus, farm advisors, growers associations, county horticultural commissioners and power companies of California. This effort is the result of a message sent out by power admisistrator H. G. Butler to the organizations in touch with the farmer with the request that every farmer who uses electricty be asked to cooperate with him in the effort to reduce the existing and threatened shortage. In his message, Mr. Butler said:

"May we have your help and cooperation in explaining the power situation to the farmers and asking them to assist themselves, and all other power users in the state, by doing their electric pumping nights and Sundays, and as far as they can, after the first of May. If we can reach the farmers who operate electric pumps and enable them to understand the situation we believe we can secure their help to such an extent that the threatening power shortage of this year will be materially less than it would otherwise be.

"We suggest that you bring these facts to the attention of the farmers:

"First. The power shortage has been caused by deficient rainfall in California and by large increases in the demand for power. It extends practically all over the State except in the small territory served by the San Diego Consolidated Gas & Electric Company.

"Second. The most important single thing that can be done to minimize this shortage is to make the total demand on the power companies as uniform as possible during the week and during the twenty-four hours of the day. A uniform load enables the power companies to operate their steam plants to full capacity all the time and this makes more power available.

"Third. During the irrigation season the agricultural pumping load makes by far the heaviest demand on the resources of the power companies, and consequently it is the load from which the greatest relief is secured when it is shifted from day to night and to Sundays, as these are the times when the use of power for other purposes is at a minimum.

"Fourth. It should be understood that the farmers are not singled out in the request to make this change in their hours of operation. Other industries, as far as possible, will be required to follow this practice.

"Fifth. The local representatives of the power companies will render such assistance as they can in helping the farmers make the change contemplated."

TRADE NOTES

Change in Location —

The California Electrical Construction Company of San Francisco has moved to 681 Mission Street, where it has a ground floor location and better stock-room facilities.

Change in Department Office —

The manufacturing sales department of the Wellman-Seaver Morgan Company, which handles the company's sales of rubber equipment and machinery, has moved from the company's Akron office to its general offices at 7000 Central Avenue, Cleveland. The department is in charge of L. N. Ridenour.

Agents for China Appointed —

The Roller-Smith Company, New York City, manufacturers of electrical instruments, meters and circuit breakers, announces the appointment of the American Manufacturers Export & Import Corporation, Seattle, Washington, as its agent for the Republic of China. This company has branch offices in Shanghai, Hong Kong and Hankow. The Roller-Smith Company also announces the appointment of Mr. Hammond D. Baker as manager of its Detroit office. After receiving his discharge from the army, Mr. Baker went with the United Motors Corporation as technical traveling representative, later giving up this position to join the sales department of the Hoskins Manufacturing Company of Detroit, from which concern he resigned to accept the position with the Roller-Smith Company.

Furnaces in France and Italy —

The Electric Furnace Construction Co., Philadelphia, reports the successful starting up of a "Greaves-Etchells" Electric Furnace of half-ton capacity at the works of Charles Bertolus in Bellegarde, France, and of a one-ton "Greaves-Etchells" Furnace at the works of Fonderie Ambrogio Necchi, Milan, Italy. On the latter furnace, the charges have been poured after two slaggings in just over two hours per charge, with an energy consumption of under 800 units per ton.

The successful starting of "Greaves-Etchells" Electric Furnaces at the works of the Dodge Steel Castings Co., Philadelphia, American Radiator Co., Buffalo, N. Y., and Hammond Steel Co., Syracuse N. Y., is also reported.

Removed from Chicago to New York —

The general offices of the Chicago Pneumatic Tool Company, have been transferred to the Chicago Pneumatic Building, a new 10-story structure erected for exclusive use of the Company on 44th St., New York.

Arrangements carefully made in advance, made possible the jump of this large organization across half of the continent without interference to the normal routine of business except for a brief period.

The Chicago, District Sales Branch previously in the Fisher Building has been moved at the same time to commodious new quarters on Chicago's new Boulevard Link, at 300 North Michigan Boulevard. The Chicago Service Branch formerly at 521 South Dearborn Street has been consolidated with the Sales Branch at the new address.

WHERE THE MEN OF THE INDUSTRY MEET

(The place where you can find where and when the other man meets. Information as to changes in officers, or additions or corrections, should be addressed to the Service Editor, Journal of Electricity. It is hoped to keep this directory up to date, so that travelers in a strange town who wish to attend the meetings of allied groups may not be misdirected. — The Editor.)

A. I. E. E.—WESTERN SECTIONS

National Officers
President—Calvert Townley, Westinghouse Electric & Manufacturing Company.
Secretary—F. L. Hutchinson, Engineering Society, Bldg., New York City.
Meetings—Monthly.

Denver Section
Chairman—Prof. H. S. Evans, Univ. of Colorado, Boulder.
Secretary—Robt. B. Bonney, Mountain States Tel. & Tel. Co., Denver, Colo.
Meetings—Third Saturday of each month, at the Shirley Hotel.

Los Angeles Section
Chairman—Clem. A. Copeland, Bureau of Power and Light, Los Angeles.
Secretary—R. W. Sorensen, California Institute of Technology, Pasadena, Cal.
Meetings—Second Tuesday of each month.

Portland Section
Chairman—E. F. Whitney, General Electric Co., Electric Bldg, Portland, Ore.
Secretary—W. C. Heston, Portland Ry. Light & Power Co., Portland, Ore.
Meetings—Monthly.

San Francisco Section
Chairman—W. G. Vincent, 445 Sutter St., San Francisco.
Secretary—Allen G. Jones, Rialto Bldg., San Francisco.
Meetings — Fourth Friday each month—Engineers' Club, 7 p.m.

Seattle Section
Chairman—G. E. Quinan, Puget Sound Power & Light Co., 205 Electric Bldg.
Secretary—Willis T. Batcheller, Seattle Light & Power System, Seattle, Wash.
Meetings—Monthly on third Tuesday in Chamber of Commerce Assembly Room, 9th floor, Arctic Bldg.

Spokane Section
Chairman—J. E. E. Royer, Washington Water Power Co., Spokane, Wash.
Secretary—Foster Russell, Symons Bldg., Spokane, Wash.
Meetings—Third Friday of each month.

Utah Section
Chairman—Markham Cheever, Utah Power & Light Co., Salt Lake City, Utah.
Secretary—T. A. Purton, General Electric Co., Newhouse Bldg., Salt Lake City, Utah.
Meetings—Third Wednesday of alternate months, 8 o'clock. Assembly Room of Commercial Club, Salt Lake City.

Vancouver Section
Chairman—R. F. Hayward, Western Canada Power Co., Ltd., Vancouver, B. C.
Secretary—T. H. Crosby, Canadian Westinghouse Co., Vancouver, B. C.

A. I. E. E.—WESTERN BRANCHES

Idaho University Branch
Meetings — First Wednesday evening of each month from October to June.

Montana State College Branch
Chairman—Jesse Flynn, Bozeman, Mont.
Secretary—J. A. Thaler, Bozeman, Mont.
Meetings—Third Friday of every month of the school year in the Electrical Bldg.

Oregon Agricultural College Branch
Chairman—F. A. Roehrig, Oregon Agr. College, Corvallis, Ore.
Secretary—Roy Avrit, Oregon Agr. College, Corvallis, Ore.

Stanford University Branch
Chairman—R. Lewelling, Stanford University, Cal.
Secretary—H. P. Wickersham, Stanford University, Cal.

State College of Washington Branch
Chairman—Glen Langdon, Pullman, Wash.
Secretary—Claude Kreisher, Pullman, Wash.
Meetings—Bimonthly at Mechanics Art Bldg., Pullman, Wash.

California Institute of Technology Branch
Chairman—R. M. Otis, Throop Dormitory, Pasadena, Cal.
Secretary—D. D. Smith, Cal. Inst. of Tech., Pasadena, Cal.

University of California Branch
Chairman—H. C. Silent, University of California, Berkeley, Cal.
Secretary—M. L. Almquist, University of California, Berkeley, Cal.

University of Colorado Branch
Chairman—D. H. Rymer.
Secretary—Lee J. Murray.
Meetings—First and third Thursdays of each month of the school year in the Engineering Building, University Campus.

University of Washington Branch
Chairman—G. R. Rice, Univ. of Washington, Seattle, Wash.
Secretary—McKinley Donovan, Univ. of Washington, Seattle, Wash.
Meetings—Monthly, first Tuesday, Forestry Bldg.

CONTRACTOR-DEALER ASSOCIATIONS

National Association of Electrical Contractors and Dealers
Chairman—W. Creighton Peet.
Secretary—W. H. Morton, 110 West 40th St., New York.
Executive Committeemen, Pacific Division—J. R. Tomlinson, Portland; J. F. NePage, Seattle.

British Columbia Ass'n Electrical Contractors and Dealers
President—E. Brettell, Vancouver, B. C.
Secretary—R. G. Hargreaves, 422 Pacific Bldg., Vancouver, B. C.

California Ass'n of Electrical Contractors and Dealers
Chairman—Clyde L. Chamblin, 641 Mission St., San Francisco, Cal.
Secretary—J. W. Redpath, New Call Bldg., San Francisco, Cal.

California Sections

East Bay Electrical Trades Association
President—Hugh Kimball, 526—13th St., Oakland, Cal.
Secretary—J. M. Gregory, Woodmen od the World Bldg., 16th & Clay St., Oakland, Cal.

Electrical Contractors and Dealers Ass'n of San Francisco
President—T. J. Bennett, Rex Electric Co., San Francisco.
Secretary—Louis R. Ardouin, San Francisco.

Imperial Valley Section
President—Jerome Aiken.
Secretary—R. O. Graham, 123 Second St., Calexico, Cal.

Kern County Section
President—A. K. Carsen.
Secretary—H. J. Anderson, Taft, Cal.

Long Beach Section
President, J. W. Lane.
Secretary—A. R. Dunn, 233 East Third St., Long Beach, Cal.

Monterey Bay Electrical Contractors and Dealers
President—W. Cox, Santa Cruz.
Secretary—D. K. Noggle, Monterey.

Northern California Electrical Contractors and Dealers
President—W. H. Gribble, Sacramento.
Secretary—H. Berg, Sacramento.

Orange County Section
President—W. B. Holland, Alaheim, Cal.
Secretary—H. J. Snow, Orange, Cal.

Orange Belt Section
President—E. J. Field.
Secretary—H. A. Snyder, 337 F Street, San Bernardino, Cal.

Sacramento Section
President—J. C. Hobrecht.
Secretary—Jas. Woods, 1110 J Street, Sacramento.

Santa Clara Section
President—Chas. Faser, 10 S. 10th St., San Jose.
Secretary—P. D. Cambiano, 161 S. 2nd St., San Jose.

San Diego Section
President—J. H. Leavitt.
Secretary—J. F. Zwiener, 995 So. St., San Diego.

San Joaquin Section
President—H. H. Courtright.
Secretary—Clyde Smith, 1230 J St., Fresno.

San Mateo Section
President—H. B. Weaver
Secretary—M. E. Ryan, 205 Main St., Redwood City.

Southern California Electrical Contractors and Dealers
President—G. E. Arbogast, 724 So. Olive St., Los Angeles, Cal.
Secretary, Assistant—H. M. Mikesell, 628 Union Bldg., Los Angeles, Cal.

Denver Electrical Contractors' Association
President—E. C. Headrick.
Secretary—C. N. Shannon, 227 Coronado Bldg.
Correspondence Secretary—L. B. Roberts, 227 Coronado Bldg., Denver, Colo.
Meetings, 2nd and 4th Monday nights of each month.

Electrical Contractors & Dealers of Salt Lake City
President—G. W. Forsberg.
Secretary—E. H. Eardley, Eardley Bros., Salt Lake City.
Meetings—Saturdays, 1 p.m.

Montana Ass'n of Electrical Contractors and Dealers
President—J. C. Currah, Helena, Mont.
Secretary—M. Downing, Butte, Mont.

Oregon State Ass'n of Electrical Contractors and Dealers
President—R. C. Kenney, 388 Burnside Street, Portland.
Secretary—U. P. Mundt, Portland, Ore.

Portland Local Ass'n of Electrical Contractors and Dealers
President—Roy C. Kenney, Portland.
Secretary—H. C. Jones, 306 Concord Bldg., Portland.
Meetings—Alternate Mondays at Imperial Hotel Grill.

Washington Ass'n of Electrical Contractors and Dealers
President—V. S. McKenny, NePage & McKenny Co., Armour Bldg., Seattle, Wash.
Secretary—Forrest E. Smith, Seattle, Wash.
Meetings—Quarterly—second Thursdays of March, June, September and December.

JOBBERS' ASSOCIATIONS

Electrical Supply Jobbers Association
General Secretary—Franklin Overbagh, 411 So. Clinton St., Chicago, Ill.
Meetings—Semi-annual.

Pacific Coast Electrical Supply Jobbers
President—T. E. Bibbins, 575 Mission St., San Francisco.
Secretary—Albert H. Elliot, 544 Market St., San Francisco.

Electrical Credit Ass'n of the Pacific Coast
President—R. J. Holterman, Holabird Elec. Co., San Francisco.
Secretary—Albert H. Elliot, 544 Market St., San Francisco.
Meetings—Annually; San Francisco; May.

OF ELECTRICAL INTEREST

California Electrical Cooperative Campaign
Chairman Advisory Committee—L. H. Newbert, 445 Sutter St., San Francisco.
Secretary—Captain Howard Angus, New Call Bldg., San Francisco.

Colorado Electric Light, Power and Railway Association
President—E. A. Phinney, Jefferson Co. Power & Light Co.
Secretary-Treasurer—F. P. Safford, Denver Gas & Electric Co., Denver, Colo.

Electric Cooperative League of Los Angeles
President—Ralph B. Clapp, San Fernando Bldg., Los Angeles.
Secretary-Treasurer—Carl M. Heintz, Westinghouse Electric & Mfg. Co., Los Angeles.

Electric Metermen's Association
President—J. E. Bridges, Westinghouse Electric & Manufacturing Company.
Secretary—A. E. Coney, Great Western Power Company, San Francisco.
Meetings—About every 60 days.

Illuminating Engineering Society
President—S. E. Doane.
Secretary—Clarence L. Law.
Western Representatives—Romaine Myers, Bacon Bldg., Oakland, Cal.; C. M. Masson, Edison Bldg., Los Angeles; F. H. Murphy, Portland Railway Light & Power Co., Portland, Ore.; W. R. Putnam, Utah Power & Light Co., Salt Lake City; Fred A. Osborn, University of Washington, Seattle, Wash.
Meetings—First Tuesday each month.

National Electric Light Association
President—R. H. Ballard, Southern California Edison Company.
Secretary—T. Comerford Martin, 29 West 39th St., New York.

New Mexico Electrical Association
President—E. A. Roberts, Public Utilities Co., Carlsbad, New Mexico.
Secretary—Chas. E. Twogood, Albuquerque Gas & Electric Company, Albuquerque, N. Mex.

Northwest Electric Light and Power Ass'n
President—John B. Fisken, Washington Water Power Company.
Secretary—L. A. Lewis, Spokane, Wash.
Meetings—Convention held annually. Executive Committee, governing body of Association, meets upon call of its chairman.

Pacific Coast Section, N. E. L. A.
President—A. E. Wishon, San Joaquin Light & Power Corporation, Fresno, Cal.
Secretary—A. H. Halloran, Journal of Electricity, Rialto Bldg., San Francisco.
Meetings—Annually, in April.

Portland Section, N. E. L. A.
Chairman—F. H. Murphy, Portland Railway Light & Power Company.
Secretary—Geo. Bowen, Portland, Ore.

San Francisco Electrical Development League
President—E. O. Shreve, General Electric Co., San Francisco.
Secretary—R. D. Compton, Pacific Gas & Electric Co., San Francisco, Cal.
Meetings—Every Monday, 12:10 p.m.; luncheon, Palace Hotel, San Francisco.

Southwestern Electrical and Gas Association
President—W. A. Sullivan, Shreveport, La.
Secretary—H. S. Cooper, 403 Slaughter Bldg., Dallas, Texas.

Synchronous Club
Secretary—H. N. Beecher, City Hall, Los Angeles.

Telephone and Telegraph Society of the Pacific Coast—San Francisco Section
President—W. H. Brommage, Pacific Tel. & Tel. Co., San Francisco.
Secretary—Chas. H. Dobson, 835 Howard St., San Francisco.

MECHANICAL ENGINEERS

National Officers
President—Col. Fred J. Miller, 2905 Singer Bldg., New York.
Secretary—Calvin W. Rice, Engineering Society Bldg., New York City.

Los Angeles Section, A. S. M. E.
President—Charles Burnham, Los Angeles.
Secretary—R. W. Lacy, 600 Washington Bldg., Los Angeles.
Meetings—Quarterly.

Oregon Section, A. S. M. E.
President—B. C. Hall, Willamette Iron & Steel Works.
Secretary—E W. Lazell, Chem. & Efficiency Engr., 537 Railway Exchange Bldg., Portland.

San Francisco Section, A. S. M. E.
President—W. F. Durand, Stanford University, Palo Alto, Cal.
Secretary—Jas. A. Kinkead, Rialto Bldg., San Francisco.
Meetings—First Tuesday of each month.
Meetings—Quarterly.
Thursday lunches have been arranged at the Engineers' Club, 57 Post St.

Washington Section A. S. M. E.
President—E. O. Eastwood, Univ. of Wash.

AMERICAN ASSOCIATION OF ENGINEERS

National Officers
President—W. H. Finley, President Chicago & Northwestern Railroad.
Secretary—Frederic Bass, 29 S. La Salle St., Chicago.

Los Angeles Chapter, American Ass'n of Engineers
President—E. G. Shiebley.
Secretary—A. L. Harris, Central Bldg., Los Angeles.

Oregon Chapter, American Ass'n of Engineers
President—W. H. Marsh.
Secretary—R. W. Barnes.

Pacific Northwest Society of the American Ass'n of Engineers
President—S. D. Clinton, Vulcan Iron Works.
Secretary—J. A. Hopkins, Seattle Boiler Works.

San Francisco Chapter, American Ass'n of Engineers
President—William S. Wollner.
Secretary—A. G. Mott.

ENGINEERS' CLUBS

Engineers' Club of Oakland
President—R. S. Chew, Oakland Chamber of Commerce, Oakland, Cal.

Engineers' Club of Sacramento
President—George S. Nickerson, 914 Forum Bldg., Sacramento.
Secretary—P. M. Noeboe, State Department of Engineering, Forum Bldg., Sacramento, Cal.

Engineers' Club of San Francisco
President—Ely C. Hutchinson, Pelton Water Wheel Company, San Francisco.
Secretary—Allen G. Jones, Rialto Bldg., San Francisco.
Annual Meeting—October.

The Engineers' Club of Seattle
President—H. E. Horrocks, Seattle, Wash.
Secretary—E. J. Bartells, Northern Life Bldg., Seattle, Wash.
Meetings—Thursday noon at the club rooms at 410 Arctic Bldg. A buffet luncheon is served every day. A special welcome is extended to all engineers visiting the city.

JOINT ORGANIZATIONS

Colorado Engineering Council
President—Arthur Ridgway, 810 Equitable Bldg., Denver.
Secretary-Treasurer—Robert J. Grant, 614 Interstate Trust Bldg., Denver.

Joint Committee Technical Societies of Los Angeles
Chairman—George A. Damon, San Fernando Bldg., Los Angeles.
Secretary—W. K. Barnard, 705-6 Central Bldg., Los Angeles.

Joint Council of the Societies of San Francisco
Chairman—C. D. Marx, Stanford University.
Secretary—Nathan Bowers, Rialto Bldg., San Francisco.

Spokane Engineering and Technical Ass'n
President—L. K. Armstrong, A. S. M. E.
Secretary—A. D. Butler, City Engineer, Spokane, Wash.
Meetings—Third Friday of each month. Joint with A. S. C. E., A. I. E. E. and A. S. M. E.

MISCELLANEOUS

American Ass'n for the Advancement of Science—Pacific Division
President—John Campbell Merriam, University of California; Acting Chairman National Council of Research.
Secretary (acting)—J. R. Douglas, 430 Library, University of California, Berkeley, Cal.
Meetings—Annual.

Foreign Trade Club
President—W. H. Hammer, Monadnock Bldg., San Francisco.
Secretary—Aubrey Drury, Monadnock Bldg., San Francisco.
Meetings—238 Merchants Exchange Bldg., San Francisco. Every Wednesday evening.

Idaho Society of Engineers
President—W. H. Gibson, Mountain Home, Idaho.
Secretary—Ira F. Shaffner, Boise, Idaho.

Pacific Coast Gas Association
President—A. B. Day, Los Angeles Gas & Electric Co.
Secretary—Henry Bostwick, 445 Sutter St., San Francisco.

Society for Promotion of Engineering Education
Secretary—H. J. Bishop, University of Pittsburg, Pittsburgh, Pa.

Utah Society of Engineers
President—Leonard Cahoon
Secretary—Wm. H. Kelsey.
Meetings—3rd Wednesdays except May, June, July and August.
Meetings—Quarterly.

LATEST IN EVERYTHING ELECTRICAL

NEW ELECTRIC RANGES

The two latest models of electric ranges which are being manufactured by the Simplex Heating Company of Cambridge have many features which will make them popular with the housewife.

The new Simplex range number twenty-nine above shows a most compact and convenient arrangement of oven, warming ovens, and electric plates. Range number twenty-five is especially well adapted to the small kitchenette.

The enclosed unit obtains the intense red heat which is so conducive to quick and satisfactory results in baking. It will be seen from the illustrations that the vertical switch panels for operating the ranges are arranged so as to add to their general appearance. Being made of white enamel they are a very clean and clearly marked surface so that the indicating pointers on the switches are very easily read.

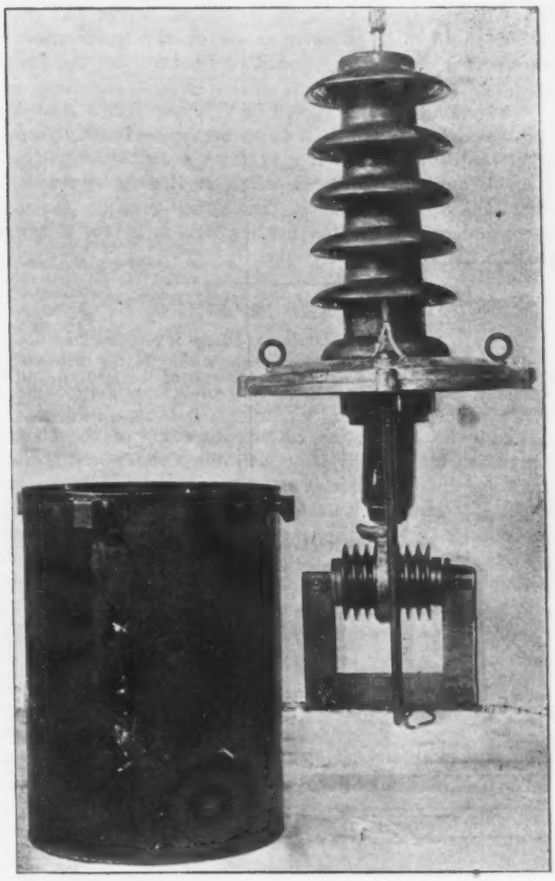
HIGH VOLTAGE CURRENT TRANSFORMER

A certain inexpensive, accurate, high voltage current transformer has been manufactured and is being used by one of the largest power companies in the United States.

It is designed for 60-kv. and 100-kv. lines both for indoor and outdoor service, with single and double ratios. By the loosening of four cap screws the transformer can be raised out of its case, all parts being very accessible. The primary winding is wound in the center of the corrugated insulating bushing, suspended from the terminal rods, which are cemented to the outlet insulating bushing.

A cast clamp shackle supports the weight, and the single ratio transformer is used as one turn of the primary winding. On the double ratio transformers all leads from the winding are brought through the shackle and are connected at top of the shackle by cap screws. The case and cover are made of tank steel electrically welded, the outlet bushing being cemented in the cover. The secondary is wound in two coils, one sliding in each end of the bushing, and are connected in series, the leads passing around the core to the bottom and brought through the cover by metal conduit. The core is built up of a high grade of silicon steel (selected from samples and tests made of various steels), giving the least loss per pound. It is piled with staggered butted joints and clamped at the corners by brass machine screws.

The ratio of this transformer is tested by a special standard transformer, and a differential wattmeter, the disc of the wattmeter remaining quiet at all loads. The sensitiveness of this differential wattmeter is tested by connecting



The above shows how this high voltage current transformer can be taken out of its case so that all parts are easily accessible. This can be done by the loosening of four cap screws which can be seen on the case in the picture.

the two current coils in series, short circuiting the terminals with a small wire, connecting the center tap of current circuit to the center of the shorting wire, applying potential to potential coil, and the disc will remain quiet. Placing the hand on the shorting wire either side of the center increases the resistance of the wire by the heat of the hand, and the disc starts to rotate. One can plainly see the accuracy of

ratio between standard and the one on test when the disc of the wattmeter remains perfectly still at all loads.

Any difference in ratio is corrected by driving up the lamination, or tightening the clamping screws; at other times a turn of secondary must be added or subtracted, as the case may be.

This transformer is being used for metering power sold direct to the consumer, for relays and solenoid trips.

The 60-kv. transformers are given 100-kv. high potential test, and the 100-kv. transformers 150-kv. test before leaving the factory.

SAFETY CUTOUT FOR ELECTRICAL HEATING DEVICES

There is a recognized fire hazard from the overheating of electrical devices, such as pressing irons, when the operating current is left on indefinitely. An ordinary fuse which melts only in the case of overload fails to prevent such overheating due to the normal current. A device has been invented by Wilhelm Gattiker and Wilhelm Baumann, Nordstrasse 273, Zurich, Switzerland, which consists of a fuse which melts when the device reaches an unsafe temperature. It consists of a wire or strip of a metal alloy similar to fuse metal which is included in the electrical circuit and which is designed to melt as soon as an unsafe temperature is reached, thus opening the circuit and cutting off the supply of energy.

The cutout is constructed in different forms according to the devices with which it is to be used. It may form a part of the device itself; it may form a connection between the device and the leading-in wires, or it may be connected in the lead wires themselves. The cutout may be placed on any convenient part of the heating device, as for example, a plug in the wall of the device.

BOOKS AND BULLETINS

Electric Railway Directory

Published semi-annually in February and August by the Directory Department of the Electric Railway Journal of the McGraw-Hill Company, Inc., Tenth Avenue at 36th Street, New York. Subscription price, $7.50 per year. Single copy, $4.00.

The February edition of this directory of the electric railway companies in the United States, Canada and Mexico, contains information which has been corrected up to December, 1919. It contains a list of the electric railways of these three countries of North America, arranged by states and cities, a list of railway associations, of national and state railroad and public utility commissions, and a numerical index to electric railway companies as well as an alphabetical list of electric railway officials and operating men and statistics of the electric railway industry.

In bringing the directory down to date a great many changes have been made. For example, there are 1450 changes in personnel, 650 changes in power plant and substation equipment, 500 in mileage and rolling stock, 44 receivership notes, and fifteen reorganizations.

The Organization of Industrial Scientific Research

By C. E. Kenneth Mees; 175 pp. 5¾ x 8 in. Published by McGraw-Hill Book Company and for sale by Technical Book Shop, Rialto Building, San Francisco. Price $2.00.

As most of recent industrial progress has been based upon the results first tried out in the research laboratory it behooves the laboratory worker and the heads of manufacturing concerns to understand how to organize their forces most effectively. The author of this text has drawn from the wealth of his experience as director of the research laboratory of the Eastman Kodak Co. and also from the experience of such concerns as the U. S. Steel Corporation, the American Telephone & Telegraph Company and the General Electric Company to indicate to others how research work may be successfully organized. He answers questions as to the cost of starting and maintaining research workers, where new men may be obtained, what may be expected in the way of results and how to organize a research department. He treats of various types of laboratories, the selection of a staff and equipment and design for specific industries. For any one concerned with such problems the book will prove invaluable.

Elements of Steam and Gas Power Engineering

By Andrew A. Potter and James P. Calderwood; 304 pp. 5½ x 8 in., 225 illustrations. Published by McGraw-Hill Book Company, New York City, and for sale by Technical Book Shop, Rialto Building, San Francisco. Price $2.50.

'Tis most refreshing for the practical man, not familiar with the application of mathematics to thermodynamics, to find a simple, straightforward, usable account of the various types of machinery found in steam and gas power plants. The authors of this book, which possesses this pleasing character, have applied their experience in teaching engineering students and have produced a text which should be fully as valuable to men responsible for the practices of steam or internal combustion engine plants as to students and salesmen desiring to familiarize themselves with power plant equipment. Mathematics, beyond simple arithmetic, is tabooed throughout the text. Pictures of modern equipment are abundant. The first 190 pages are devoted to steam power generation and utilization, including fuels, combustion theory of steam generation boilers, auxiliaries, accessories, steam engines, turbines and the testing of steam power equipment. The next 70 pages take up the study of the internal combustion engine, fuels, various auxiliaries and testing methods. The last two chapters are concerned with the application of steam and gas power to locomotives, automobiles, trucks and tractors. In each case the treatment covers fundamental principles, structural details, operation and management. The entire text is admirably adapted to the needs of the man who wants to get a good general idea of power apparatus.

Engineering

Circulars to Aid Sales

The Cutler-Hammer Manufacturing Company of Milwaukee has prepared, in connection with other forms of dealer helps, some ten or twelve folders for use by dealers, jobbers and central stations. These folders have been furnished upon specific request and have not only increased the sale of 70-50 switches but also heating appliances on which they are used.

The Harvey Hubbell, Inc., of Bridgeport, Conn., offers to send a supply of its new Circular No. 192 to dealers upon request. This circular describes and illustrates the superior Hubbell reflectors and is imprinted with the dealer's name.

The new water supply system of Victoria, British Columbia, is excellently described in a booklet published by Sanderson & Porter, Engineers.

What Is a Shop? is the question answered by the Westinghouse, Church, Kerr & Company, Engineers and Constructors, in a recently published pamphlet which pictures the many shops which this company has designed and built.

DEVELOPING NATIONAL WATER POWER

[Continued from page 478]

Indiana (#17 F). Water power in Indiana can in no case compete with steam power. The only situation under which water power can be used in Indiana is as an auxiliary to a steam power plant but never with a steam plant as an auxiliary to a hydro power plant.

Iowa (#25 F). Yes.

Kansas (#51 F). The chief value of water power in this state will be to supplement steam plants during the period when there is sufficient flow in the streams to warrant the use of water power. With the present high prices of coal and oil more attention is being given by power companies to this phase of water power development.

Kentucky (#23 F). Yes.

Maine. See answer under Connecticut for New England states.

Maryland (#22 F). Probably, this depends on the relation which is at present fluctuating between the increased cost of development on one hand and the increased cost of coal on the other since pre-war costs.

Massachusettts. See answer under Connecticut for the New England states.

Minnesota (#19 F). The water powers of this state are subject to great reduction in the winters, due to freezing and to some extent to droughts in the summer. On the other hand, if operated in connection with adequate steam plants they do show a decided tendency to reduce the average cost per kw.-hr. of current generated and at the present price of coal most certainly can compete with power produced entirely by coal.

Nebraska (#15 F). I do not feel that the development of undeveloped water powers offers any economies over the continued production of power by steam. Such water power, if developed under favorable conditions, could successfully compete with power production by coal.

New Hampshire. See answer under Connecticut for the New England states.

New York (#24 F). The figures represent the quantities of undeveloped power which might be developed economically under present condition of coal costs, steam generating efficiencies and industrial market within transmitting distance of the power sites in the state. The theoretical potential power of the streams exceeds this by an amount which is considerable, but not exactly known, although it is probable that posterity will be forced to make use of it when the coal supply is sufficiently diminished.

(#27 F). Water powers are much more economical than steam power at the present price of coal unless the load served is of very short duration, and in these days of interconnecting systems, we hardly have such a thing as a short hour load.

(#45 F). Water power can successfully compete with power produced continuously by coal excepting in the vicinity of New York City. It can be transmitted electrically with advantage to most of the large towns and industrial centers to carry continuous loads, leaving steam plants to be used only for peak loads and emergency purposes.

Pennsylvania (#39 F). In general, the development of water powers in this state will not offer any material economies over the production of power by steam. Properly developed in an economical manner there are many chances where such water powers could be used for relatively short hours daily to take the peak loads from steam stations, thereby minimizing the costs of steam plants and improving the load factor of such steam plants with a consequent improvement in fuel economy. Plants of this nature, however, would be developed without any extremely large supporting impoundage, so that in the main they could be rebuilt reasonably cheap. At the present time water powers cannot be developed to compete with coal for the delivery of power.

Vermont. See answer under Connecticut for the New England states.

Wisconsin (#43 F). This question cannot be answered yes or no, as there are a great many factors that enter into the economical development of water power. A water power may not be economical to develop for one business while in the case of another business it might be very profitable. We therefore cannot answer this question, as we should advise each individual possibility be investigated separately.

APPENDIX "B"

Following is a list of publications giving a large part of the present available data and discussion on the subject of water power development.

This list is by no means a complete bibliography of the subject, but it is believed to include most of the authentic publications of data on water power development and its closely cor-related subjects (economic, legal, financial and engineering), as well as a number of important recent papers, reports and discussions on the subject.

FEDERAL GOVERNMENT PUBLICATIONS

"Conservation of Water Resources." U. S. Geological Survey Water Supply Paper #234. Reprint from Report of the National Conservation Commission, February, 1909.

OTHER WATER SUPPLY PAPERS OF THE U. S. GEOLOGICAL SURVEY

"Report of the Commissioner of Corporations on Water Power Development in the United States." March 14, 1912.

"Electric Power Development in the United States." Report of Secretary of Agriculture to the Senate, 1916. Senate Document No. 316 ("Merrill Report").

"Hearings Before the Committee on the Public Lands of the House of Representatives on the Water Power Bill, H. R. 14893." April 30th to May 8th, 1914.

"Hearings Before the Committee on Water Power of the House of Representatives." March 18th to May 15th, 1918.

"Conservation Through Engineering." By Franklin K. Lane, U. S. Geological Survey Bulletin No. 705. (Extract from Annual Report of the Secretary of the Interior, 1919.)

STATE GOVERNMENT PUBLICATIONS

Water Codes of Various Western States. Report of Various State Engineers, and State Water Supply and Drainage Commissioners.

OTHER MISCELLANEOUS PUBLICATIONS

"Elements of Western Water Law." (1918.) By A. E. Chandler, Technical Publishing Co., San Francisco.

"Law of Irrigation and Water Rights." By Clesson S. Kinney of the Salt Lake City Bar. (1912.) Bender Moss Co., San Francisco.

"Hydroelectric Energy as a Conserver of Oil." Journal of Electricity, Vol. 39, Page 299.

"Water Rights in the Western States." By Samuel C. Wiel of the San Francisco Bar. (1911.) Bancroft Whitney Co., San Francisco.

"Water Power in the Southwestern States." By E. C. Murphy, Journal of Electricity, Vol. 39, Page 549.

"State and National Water Laws with Detailed Statement of the Oregon System of Water Titles." By John H. Lewis, Ex-State Engineer of Oregon. Reprint from Transactions of American Society of Civil Engineers, Vol. 76, Page 637 (1913).

"War Service of Electrical Energy." By Robert Sibley, Journal of Electricity, Vol. 40, Page 112.

"Facts About Water Power." Pamphlet prepared by the Executive Committee of the Water Power Development Association, Munsey Building, Washington, D. C.

"Power Resources in Southern California." By H. A. Barre, Journal of Electricity, Vol. 40, Page 330.

"Water Powers of British Columbia." By Arthur V. White, Consulting Engineer, Commission of Conservation. Canada (Ottawa, 1919).

"Joint Operation of Power Companies." By J. P. Jollyman, Journal of Electricity, Vol. 40, Page 402.

"Report on Columbia River Power Project." By L. F. Harza. (1914.) Technical Publishing Co., San Francisco.

"America's Energy Supply." By Chas. P. Steinmetz, A. I. E. E. Proceedings, Vol. 37, Part 2, Page 985 (June, 1918).

"Seventeen Water Development World Records." Journal of Electricity, Vol. 41, Page 6.

"Electrochemical Industries and Their Interest in the Development of Water Powers." By Lawrence Addicks, A. I. E. E. Proceedings, May, 1916.

"Three Major Power Possibilities in California." By F. H. Fowler, Journal of Electricity, Vol. 41, Page 12.

"Water Power Development and the Food Proplem." By Allerton S. Cushman, A. I. E. E. Proceedings, May, 1916.

"Undeveloped Water Power in the Southwest." By F. H. Fowler, Journal of Electricity, Vol. 41, Page 246.

"Water Power and Defense." By W. R. Whitney, A. I. E. E. Proceedings, May, 1916.

"The West During the Last Thirty-one Years—Achievements and Possibilities." Journal of Electricity, Vol. 41, Page 342.

"Relation of Water Power to Transportation." By Lewis B. Stilwell, A. I. E. E. Proceedings, May, 1916.

"Statistical Data on Power Companies." By W. F. Neiman, Journal of Electricity, Vol. 41, Page 350.

"The Water Power Situation, Including Its Financial Aspect." By Gano Dunn, A. I. E. E. Proceedings, May, 1916.

"Power Possibilities in California." By F. H. Fowler, Journal of Electricity, Vol. 41, Page 393.

"Economical Supply of Electric Power." By W. S. Murray, Consulting Engineer, New York, and other prominent eastern engineers. Journal of the American Institute of Electrical Engineers, March, 1920; Page 219.

"Water Power Situation on the Pacific Coast." By Major George F. Sever, Journal of Electricity, Vol. 42, Page 6.

"Role of Water Power and Coal in Super Power Systems." By Philip Torchio, Chief Electrical Engineer, New York Edison Co., Journal of A. I. E. E., March, 1920; Page 315.

"Source of Power for California Railway Electrification." By F. H. Fowler and Robert Sibley, Journal of Electricity, Vol. 43, Page 371.

"New Irrigation and Power Developments." By Chas. H. Lee, Journal of Electricity, Vol. 44, Page 119.

"Water Powers of the United States." Electrical World, March 20, 1920.

"California 220,000-v, 1,500,000-kw. Transmission Bus. By R. W. Sorenson, H. H. Cox and G. E. Armstrong, Journal of Electricity, Vol. 43, Page 202.

"Prospective Power Development in the Far West." Electrical World, March 20, 1920.

"Self Interest Will Aid Electrical Development." By A. B. Wishon, Electrical World, Vol. 74, Page 1060.

ELECTRICAL WORLD

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Harnessing water power to conserve labor. By Hugh L. Cooper	1194
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Waterwheel equipment, overhauling. By C. A. Graves	203
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Water economy in hydro plants. By S. W. Wyss	727
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A. B. WEST
A. G. WISHON

WATER POWER DEVELOPMENT COMMITTEE,
NATIONAL ELECTRIC LIGHT ASSOCIATION.

NEW ELECTRICAL DEVELOPMENT

Reports of appropriations for pipe line and steam plant construction come from the Northwest while development plans requiring an expenditure of $123,000 are recorded among Pacific Central items. The Southwest reports electrical installation for pumping municipal water supply, while news of power company construction and rate increase comes from the Intermountain district.—The Editor.)

THE PACIFIC NORTHWEST

SEATTLE, WASH.—Chief Engineer Pierce of the Seattle Municipal Street Railway announces that construction of Madison loop and Madison Park will be started without delay.

SEATTLE, WASH. — Vulcan Manufacturing Company of Seattle was awarded the contract for furnishing steel roof trusses for the third unit of the auxiliary steam power plant, at $7,979.

EVERETT, WASH.—Extensions and betterments to the existing light and power plant system, calling for an expenditure of about $50,000, will be put into effect in the near future if the mayor approves an ordinance passed by the city council.

ENTERPRISE, ORE.—Enterprise Mercantile & Milling Company of this place has filed in the office of Percy A. Cupper, State Engineer, an application to divert 90 second feet of water from the Wallowa river and tributaries for generating 163.6 theoretical horsepower to be used for manufacturing electric light and power. A turbine will be installed.

EVERETT, WASH.—The Weyerhaeuser Timber Company has begun electrifying its mill "A" on the water front. A 750-kw. Allis-Chalmers steam turbine unit of the mixed pressure type will be installed. This will run normally on low pressure steam discharged from the Corliss engines in the mill and will provide electric power for operation of the planing mill and other machinery.

CENTRALIA, WASH. — The Carlisle-Pennell Lumber Company has suspended operations for 30 days at its big mill in Onalaska to permit the installation of a 2500-horsepower steam turbine. The plant will be electrically operated when operations are resumed. C. H. Rattray, construction engineer for the General Electric Company, is superintending the installation of the machinery.

SALEM, ORE.—Pending a decision of the state irrigation commission as to whether it will recommend a state guarantee of interest on a bond issue of $750,000 by the Suttles Lake irrigation district in Jefferson county, the state engineering department has sent R. D. Cooper to make an appraisal of the lands in the district. The district embrases about 13,000 acres of irrigable alnd.

KLAMATH FALLS, ORE.—W. B. Parker, local manager of the Klamath Development Company, backed by San Francisco and Spokane capitalists, has purchased the Keno Power Company. The sale includes the plant on the Klamath river near Keno, now capable of manufacturing 850 horsepower; its transmission lines, franchises and all other property. The price was $80,000. Kern Brothers, formerly of Chico, Cal., owned the Keno company.

OLYMPIA, WASH.—The State Capitol Commission awarded contracts for construction and equipment of the power and heating plant of the new capitol group. For the general construction, including the walls, tunnels and 175-foot stack with stone facing, a contract was awarded to Western Construction Company, Seaboard Building, Seattle, at $132,330. The contract for mechanical equipment was awarded to Bergh-Griggs Company of Tacoma at $124,879.

SEATTLE, WASH.—An ordinance appropriating four hundred and ninety-five thousand dollars for the completion of pipe line construction, and for the construction of a 15,000-kw. generating unit at Cedar Falls, has been passed by the city council. An ordinance appropriating five hundred and eleven thousand dollars for the completion of a new 15,000-kw. unit at the Lake Union steam plant has been referred to the utilities committee for that body's report. The funds for both of these appropriations come out of the bond issues already provided by the council.

WALLA WALLA, WASH.—In order to handle the distributing business for farm lighting systems and other electrical appliances in eastern Washington, Idaho and part of Oregon, the Electric Equipment Company will increase its capital stock from $25,000 to $75,000. This action was decided upon at a meeting of the stockholders of the corporation. The Electrical Equipment Company, which opened a store in this city several months ago, with houses in Colfax, Washington, and Lewiston, Idaho, is having such rapid growth that it was compelled to treble its capital stock in order to keep up with this growth.

HOOD RIVER, ORE.—George R. Wilbur, secretary and attorney of the East Fork irrigation district, is back from Salem, where he was informed by the state water board that a decree, just entered in the adjudication of all water rights in the Hood River watershed, granted contentions of irrigation districts and made sweeping decisions against claims of power concerns. The case, which has been in litigation since 1914, involves practically the entire $10,000,000 assessed valuation of the Hood River Valley, and from the property standpoint sets a record for such litigation in Oregon. The Powder river case, notable in Oregon irrigation litigation, involved a greater acreage.

SEATTLE, WASH.—Officials of the Marconi Wireless Telegraph Company of this city have received advice that the circuit court of appeals affirms in all respects the decision of Judge Jeremiah Meterer, denying that company the right to collect approximately $3,000,000 as damages for alleged patent infringements from the Kilbourne & Clark Manufacturing Company, of Seattle. This decision is the culmination of an extended legal battle during which the Marconi interests alleged infringement by the Seattle concerns on the so-called Marconi tuning patent. Damages of approximately $3,000,000 and an injunction preventing the local firm from manufacturing wireless telegraph equipment were sought by the Marconi company.

SALEM, ORE.—Settlement of a long-standing dispute between a company composed of Wallowa county citizens and the Enterprise Electric Company, with regard to water power rights on the Wallowa river, is in progress and probably will be effected within the next few weeks, according to Percy Cupper, state engineer, who returned here recently from eastern Oregon. The company of citizens, according to Mr. Cupper, filed for power rights on the west fork of the Wallowa river, while the Enterprise Electric Company made application for similar concessions on both the east and west forks of the stream. To bring about a settlement of the controversy and thereby prevent any unnecessary delay in development work, it is proposed to grant the application of the electric company for power rights on the east fork of Wallowa river, and hold in abeyance the filings of both applicants for rights on the west fork of the stream until the persons interested can hold a conference and enter into some agreement.

THE PACIFIC CENTRAL DISTRICT

SANTA ROSA, CAL.—Plans for a one-story building for the Pacific Gas & Electric Company in Santa Rosa, to cost $10,000, are being prepared by Architect J. W. Dolliver, 114 Sansome street, San Francisco.

SACRAMENTO, CAL.—The City Commission has started a movement to have the city own and operate its own electric plant, gas plant and street railway system. The commissioners took the plan under actual consideration upon the advice of City Attorney Archibald Yell. An ordinance will probably be introduced at the next regular meeting of the Commission.

SAN FRANCISCO, CAL.—Water problems of the Sacramento and San Joaquin delta lands were discussed at a meeting of the Emergency Water Conservation Conference and the River Lands Association, held in San Francisco May 11. According to the association, the infusion of salt water into these two rivers, as the result of fresh water shortage, is a problem that requires immediate solution.

SAN FRANCISCO, CAL.—The regular quarterly dividend of 1½ per cent on the preferred capital stock of the Atlas Power Company was declared, payable May 1, 1920, to stockholders of record at the close of business on Tuesday, April 20, 1920. The stock transfer books of the company were closed against the transfer of stock at the close of business on April 20 and reopened at 9 o'clock a.m. on Saturday, May 1.

LIVERMORE, CAL.—An irrigation project comprising a large area of the Murray Township adjacent to Livermore is being fostered by the Chamber of Commerce. The petitions now in circulation, calling for the district formation and issuance of bonds for the necessary development, will be presented to the Supervisors, following which engineering investigations will be made into the feasibility of the source of supply.

RICHMOND, CAL.—Transfer of three lots at the corner of Twenty-third street and Macdonald avenue from the Landsberger estate to the Pacific Telephone & Telegraph Company is thought to indicate that the company intends erecting a new building for its station upon the site. The location is considered one of the most advantageous in the city for such a purpose. At the present time the telephone company occupies rented quarters on Third street.

MADERA, CAL.—Thomas H. Means of San Francisco has been appointed chief engineer of the Madera irrigation district. The preliminary engineering work will be started shortly and when this is completed a bond issue will be voted to secure money to build the project. The district contemplates building one of the largest dams in the world on the San Joaquin river, which will impound over 400,000 acre feet of the water of that stream.

SUSANVILLE, CAL.—Announcement is made here that the Red River Lumber Company is negotiating for the properties here of the Lassen Electric Company and will probably assume ownership as soon as certain legal adjustments are made. The Red River company is now engaged in installing its own power house on Feather

river and will be in position to supply nearby points with electrical energy. The plans include the construction of a power line between Westwood and Susanville.

SAN FRANCISCO, CAL.—Earnings of the Great Western Power system, consisting of the Great Western Power Company of California and the California Electric Generating Company, for February and the 12 months ended February 29, 1920, compare with 1919 as follows:

	1920	1919
February gross	$ 457,327	$ 409,273
Net after taxes	259,281	244,769
Surplus, after int. and taxes	102,961	115,720
12 months' gross	5,496,548	4,831,661
Net after taxes	3,093,522	2,872,699
Surplus, after int. and taxes	1,370,887	1,321,224

OAKLAND, CAL.—The Eel river, flowing into Humboldt bay, is considered the logical source from which to secure a water supply for the east bay region, according to the recommendation of Engineer P. E. Harroun of the East Bay Water Commission, whose report has been made public. Harroun's report points out that of three sources studied, the Eel river, the McCloud river and the Hetch Hetchy, the first named offers advantages held by none of the others and that sufficient water to supply east bay needs for the next seventy-five years can be brought to the district at a total cost of $46,000,000. The engineer's report carries figures which show that the installation of the Eel river system compared to the McCloud or Hetch Hetchy projects means a saving to taxpayers of between $40,000,000 and $50,000,000, with virtually the same amount of water developed.

THE PACIFIC SOUTHWEST

SAN DIEGO, CAL.—The San Diego Electric Railway is planning to do a large amount of repair work soon, as announced by the manager of Operation, W. H. Judy.

SAN DIEGO, CAL.—The City Council has adopted an ordinance, authorizing the treasurer to sell $100,000 worth of Barrett dam bonds for $97,500, to Isaac Irwin of the Citizens Saving bank.

LOS ANGELES, CAL.—An ordinance has been adopted granting the City Railway Company a franchise to construct a double track electric railroad along Temple Street from Spring to Hoover, Los Angeles, etc.

LOS ANGELES, CAL.—Communication has been filed with the City Council by the City Railway Company giving notice of intention of laying double track along Western Ave., from Melrose Ave. to Santa Monica Boulevard.

DOUGLAS, ARIZ.—Inspection has been made of various locations east of Douglas for a site upon which to construct a water reservoir to cost about $44,000. The pipe line is to be installed from the reservoir to the City limits.

QUINCY, CAL.—Thirty-five thousand dollars is to be spent by the California Fruit Growers' Exchange in the construction of a water system at Davies Mill, this year. This is according to A. M. Mortensen, manager of the lumber department of the exchange.

CASA GRANDE, ARIZ.—Delegates of the Chamber of Commerce of this city visited Phoenix recently primarily for the purpose of a conference with representatives of the Pacific Gas and Electric Company with a view to developing the power of the Casa Grande Valley.

EL CENTRO, CAL.—Sealed bids will be received up to May 20, 1920 for the sale of $500,000 bonds of Imperial Irrigation District at its office in the Masonic Building in this city. These bonds are a portion of the third issue of $2,500,000. They are of par value of $1,000 each bearing interest at 5½% per annum, payable semi-annually.

WHITTIER, CAL.—Arrangements are being made to serve this city with 870 horsepower in motors for pumping the water supply of the city. The electrical installation will displace all of the present steam equipment. When complete the city will have one of the most up-to-date and most economical municipal water systems in the State of California.

HOLBROOK, ARIZ.—It is reported that the Santa Fe Railway Company intends to build a large electric power plant at Gallup and another at Trinidad, Colo., for the purpose of generating electricity for the electrification of the Santa Fe from Colorado to the Coast. These plants are to be followed by others. It is also said that these plants would be able to furnish light and power to towns along the line.

PERRIS, CAL.—Engineer Woodworth of the Colcan Land and Water Co., reports the engineers have been making a survey of the water situation since February and have covered about 40 miles of territory toward Perris from the dam site and are working now from a point near Winchester towards Perris and Temecula. It is thought all the field work will soon be finished and cost per acre of the system, etc., will soon be ready.

GLOBE, ARIZ.—Among the many improvements being made by the Globe Light and Power Company, is the remodeling of the electric plant, the installation of a 300 hp. Stirling boiler, and a thorough overhauling of the engines. This is about complete and will give increased power and minimize the chance of interruption in the service. All electric transmission lines will be brought up to conform with the standard of overhead construction of the N. E. L. A.

MADERA, CAL.—Thomas H. Means of San Francisco has been appointed chief engineer of the Madera irrigation district. The preliminary engineering work will be started shortly and when this is completed a bond issue will be voted to secure money to build the project. The district contemplates building one of the largest dams in the world on the San Joaquin river, which will impound over 400,000 acre feet of the water of that stream.

THE INTER-MOUNTAIN DISTRICT

SANTAQUIN, UTAH.—The city of Santaquin is considering the installation of a street lighting system on the main street, the same to be series incandescent, and to consist of about eight 1000-candle power units.

CARSON CITY, NEV.—The public service commission has denied the Nevada-California Power Company authority to discontinue operation of its electric power line from Lundy, California, to Nevada districts, excepting Fairview and Wonder.

PRICE, UTAH.—The Spring Glen Light & Water Company has recently been organized, with an authorized capital of $10,000, in shares of $100 each. Water is to be brought from Price City, and electrical energy from the Utah Power & Light Company.

TWIN FALLS, IDA.—Indicative of continuing growth of Twin Falls, is the fact that the installations of meters here by the Idaho Power Company during the year ending March, 1920, amounted to 360 more than for the preceding year. There has been no decline in the demand for electric service during the past several weeks.

RUPERT, IDA.—A delegation of business men met with the city council recently and urged that the cluster system of street lighting be put into effect instead of the single standard in use at present. The proposed plan of lighting will cover the avenue leading to the depot and will make Rupert one of the best lighted towns in the state.

OGDEN, UTAH.—Applications have been filed with the Utah State Engineer for permission to divert 200 cubic second feet from the Ogden river. This project involves eight miles of ditch, when the water will be dropped into the river again under a four hundred-foot head to develop 3750 kilowatts, which will be utilized for irrigating pumping in the vicinity.

PARK CITY, UTAH.—Electric lighting service was connected at the towns of Hoytsville and Wanship during the latter part of April. These towns are prosperous farming communities, and the extensions for electric service have just been completed by the Utah Power & Light Company. Celebrations were held in both towns, proclaiming the advent of electric service.

SALT LAKE CITY, UTAH.—Sugarhouse, a suburb of Salt Lake City, has just made an installation of thirty-two 300-watt type C lamps, which has done much in the way of improving the lighting in this enterprising community. The business men declare that no one thing, for similar outlay, has done so much to improve and advertise the section as has the installation of this electric lighting.

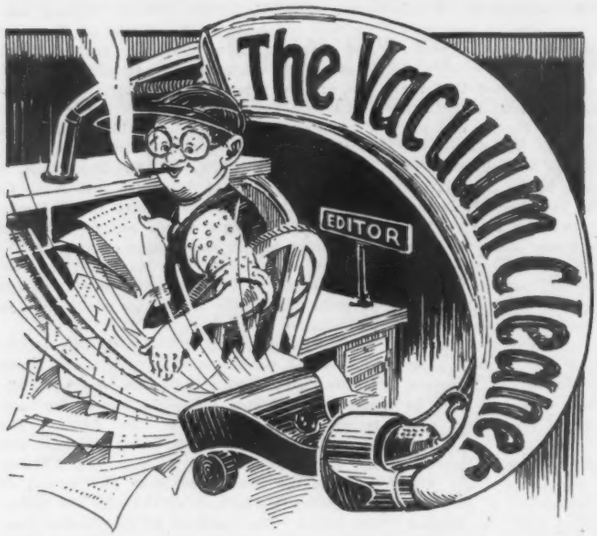
RED LODGE, MONT.—The Carbon county high school is now conducting a night school for men employed in the mines here with success that bids fair to become one of the most important departments of the school. The course is one in the fundamental principles and the simpler application of electricty. Practically all the mine electricians and several of the leading electricians of the city are taking the course. The members of the present class will form an advance class in electricity next year.

SALT LAKE CITY, UTAH—The Utah Power & Light Company, according to the company's manager at Montpelier, Idaho, W. B. Trowbridge, is planning a big building and expansion program for this spring and summer in its northern Utah and southern Idaho territory. Added improvements and enlargement of the Lifton pumping station are among the plans of the company. This pumping plant is one of the largest in the world, and is used during the irrigating season to keep the waters of Bear river up to normal flow and better, if necessary, during the heavy drain of the irrigation season.

IDAHO FALLS, IDAHO.—One of the most complete and successful reclamation by irrigation projects of this part of the country is nearing completion. This new project includes 2000 acres on the west side of the Snake river between the city of Idaho Falls and the town of Roberts in Jefferson county. Some of the best land in Idaho—over 2000 acres of it—has been brought under irrigation by this project and the land is ready today for the seed and success. The pipe line and pumping plant are installed and the water is ready and waiting for the land. The electric power to set all in motion awaits but the closing of a switch. The soil is said to be the best of the lands in the upper Snake River Valley. With the closing of a switch or two, big motors will drive 16,000 gallons of water per minute on to the now arid soil.

COLORADO SPRINGS, COLO.—The state public utilities commission and the Colorado Springs city council, on May 22 or 24, will conduct concurently a hearing on the application of the Colorado Springs Light, Heat and Power Company for an increase in rates for both gas and electricity. The company recently granted a wage increase of 25 per cent to its employes, and officials of the company assert that it is necessary that the operating revenue be increased.

More than 200 electrical experts attended a meeting of the electrical bureau of the Civic and Commercial association of this city when the first steps were taken in the movement to "electrify Denver." W. L. Goodwin and H. B. Kirkland of the General Electric Company of Schenectady, N. Y., and S. A. Chase of the Westinghouse Electric and Manufacturing Company delivered addresses urging the adoption of a cooperative policy in advertising and merchandising among the electrical supply dealers of the city. The campaign which is to be opened in Denver is a part of a national program which has been launched under the supervision of the electrical manufacturers.



The electrical home idea sounds simple and matter-of-fact enough, but its advocates are wont to plunge into elaborately poetical rhetoric, where they wallow joyously and without shame in the strangest of metaphors. At the close of a sales conference a speaker was summing up in his usual eloquent manner. "Gentlemen," he exclaimed, "the office personnel is always at your service. It is up to yourselves entirely. If in your search for fertile fields you come across a prospect rich with pollen, but do not feel quite sure of yourself, call upon me, so that like the bees we may go out together, and gathering in the honey, bring home the bacon."

* * *

Education by mail is a commonplace these days, but wives by mail has not yet become the order of the day. A California mail order house is in receipt of an order which came through the mail, on the regular order blank. Under "Quantity" was "1," under "Sizes, colors, etc.," are the words "Medium built, white." The "article wanted" is "A woman between twenty and thirty years of age." The man sending the order writes that he is "A bachelor, thirty-two years of age, and a Protestant."

* * *

Following instructions is an art which may be more entertaining than it sounds. A man working for a railroad was told by the superintendent to go along the line looking for washouts. "And don't be as long-winded in your next reports as you have been in the past," said the superintendent; "just report the condition of the roadbed as you find it, and don't use a lot of needless words that are not to the point. Write like a business letter, not like a love letter." The man proceeded on his tour of inspection and when he reached the river, he wrote to the superintendent:
"Sir:—Where the railroad was the river is."

* * *

Natural history, we have heard, is better for the young when acquired by observation than when learned out of books. It is certainly better for the old, as evidenced by the following essay on a cow, written by a small boy:
"A cow is an animal with four legs on the under side. The tail is no longer than the legs but is not used to stand on. The cow kills flies with her tail. A cow has big ears that wiggle on hinges, so does her tail. A cow is bigger than a calf but not as big as an elephant. She is made small so she can go in a barn when no one is looking. Some cows are black and some can hook. A dog got hooked. She tossed the dog what worried the cat that caught the rat that lived in the house that Jack built. Black cows give white milk; so do other cows. Milkmen sell milk to buy little girls dresses which they put water in and chalk. Cows chew cuds and each cow furnishes her own chew. That is all there is about cows."

* * *

Speaking of mentality, few of us can claim the formidable list of attainments attributed to a certain visiting negro divine, who was introduced to the congregation by the pastor as follows:
"Brethren and sistren: You-all is gwine lissen today to de interpolations of de Scripcher by a man of de mos' unusuales' containments. Our visitin' brother knows de onknowable; he thinks the unthinkable; and he kin onscrew de onscrutible!"

* * *

Electrical advertising is designed to appeal to a very large class of buyers, and we are glad to see it, but one must draw the line somewhere. The following sign, for instance, recently displayed by an electrical dealer, does not seem calculated to attract customers of the highest moral calibre:

"Don't kill your wife. Let our washing machine do the dirty work."

A neighboring restaurant, also concerned with domestic felicity, takes a more kindly attitude and advertises as follows:

"If your wife can't cook, don't divorce her. Keep her for a pet and eat here."

* * *

There is a silver lining to every cloud, according to the optimists, and even if the cloud happens to be a quarantine sign it's right if you are on the right side of it.
During an epidemic in a small Southern town every infected house was put under quarantine. After the disease had been checked, an old negress protested vigorously when the health officer started to take down the sign on her house.
"Why, Auntie," exclaimed the officer, "don't you want me to take it down?"
"Well, sah," she answered, "dey ain' be'n a bill collectah neah dis house sence dat sign went up. You-all let it alone!"

* * *

"Each in his own tongue is a sentiment which has evidently spread outside the realm of poetry:
A bellhop passed through the hall of a hotel whistling loudly.
"Young man," said the manager sternly, "you should know that it is against the rules of this hotel for an employe to whistle while on duty."
"I am not whistling, sir," replied the boy, "I'm paging Mr. Jones' dog."

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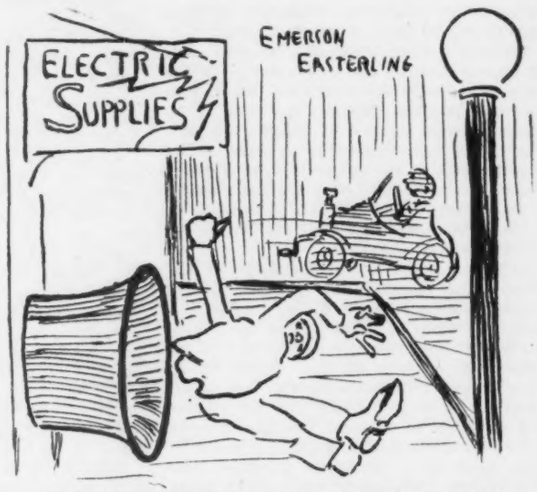

DRAWING CROWDS TO A SIDE STREET LOCATION

Why waste your money on electric signs? It seems that the article which appeared in the March 15th issue of the Journal of Electricity advocating this process is now out of date in view of the latest methods. A giant vacuum cleaner discreetly operated will bring all kinds of business to your very door. No one will be able to resist the attraction of your establishment, and even the most casual passer-by will feel irresistibly drawn towards it.

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